

Culturing Quality and Confidence
Program Guide
Aquaculture Canada^{OM} 2006



Halifax, NS

November 19-22, 2006



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Aquaculture Canada 2006 Committees / Comités

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Welcome Messages to Delegates Mots de bienvenue aux délégués

I would like to welcome you, on behalf of the Board of Directors and the conference organizing committee, to the 23rd annual meeting and conference of the Aquaculture Association of Canada: Aquaculture Canada^{OM} 2006. I would also like to thank our co-hosts – the Aquaculture Association of Nova Scotia and Nova Scotia Fisheries and Aquaculture – for their assistance.



Our conference theme – *Culturing Quality and Confidence* – speaks to various aspects of Canadian aquaculture that ensure the production of high-quality products for consumers in a sustainable manner. Fish health, best practices, environmental sustainability, policy and regulation, consumer perception, marketing; all of these and more are encompassed by this theme and are highlighted throughout our comprehensive program in special and presentations. Quality and confidence in aquaculture is a shared responsibility among us all as regulators, researchers, producers, and suppliers, and your attendance at our conference this year is an indication of your commitment to this.

This year's conference has been quite a team effort, involving a diverse group of individuals whose experiences and hard work have led to a fantastic technical and scientific agenda, social program, and inviting atmosphere for information exchange. Particularly, I would like to thank Linda Hiemstra (conference organizer) and Jason Mullen (program chair) who have tirelessly outdone themselves in leading their teams. Appreciation is also due for all the partners and sponsors of AC06.

I hope you enjoy the conference we have put together, as well as the social and networking opportunities that abound!

Chris Hendry
President, Aquaculture Association of Canada

As Conference Organizer, I welcome you to Aquaculture Canada^{OM} 2006. As with all the Aquaculture Canada^{OM} meetings, the success of this event is the result of many hours of commitment and hard work by a dedicated team of volunteers. I wish to thank everyone who has been involved with the planning of this wonderful event.



We have over 100 contributed papers - both oral and poster - and an exciting series of special sessions providing a broad range of presentation topics and the latest in information and research results. This year and for future years, we are dedicating the Student BBQ to Joe Brown, a long-time supporter and Past President of the AAC. I look forward to joining you all and raising a pint to Joe at this event.

Have a great time in Halifax and at Aquaculture Canada^{OM} 2006!

Linda Hiemstra, Conference Organizer



Aquaculture Canada^{OM} 2006

On behalf of the members and directors of the AANS I would like to welcome the Aquaculture Association of Canada and all participants to Nova Scotia and to Halifax. Given the challenges faced by associations over the past year, I'm very glad to be here as an active partner in the AAC annual conference and trade show.

It has been a very interesting year within the regional aquaculture industry. We weathered the currency crisis and saw a major consolidation initiative in the salmon sector. And, it appears the near future business environment will be equally as dynamic.

Here in Nova Scotia we see the way forward as encompassing a public policy challenge equal to the scientific, technical and business challenges facing our producers. In keeping with the times, for our annual conference, **Scotian Pride 2007**, we have adopted the theme "Getting Back to Basics" which is a call for all producers to focus on opportunities to grow their businesses and on governments to address a number of fundamental challenges to industry growth.

This year's Aquaculture Canada conference continues a history of fostering a professional dialogue among producers, the public sector and academia to work towards the betterment of our industry.

And, as a personal reward for your professional dedication, I hope everyone will save a wee bit of energy to get out and enjoy the downtown Halifax "scene".

**Brian Muise,
Executive Director,
Aquaculture Association of Nova Scotia**



It is my sincere pleasure to welcome you to Halifax, Nova Scotia and the Aquaculture Association of Canada 2006 conference.

The Government of Nova Scotia recognises aquaculture as an exciting and evolving industry. Our aquaculture industry can achieve great success as an economical and environmentally sustainable opportunity for our coastal communities.

As the aquaculture industry in Canada grows so do the many centres of excellence in aquaculture research and development. All of these achievements boost our importance on the national and international stage.

Together we can bridge the gap between research and development and commercialization, particularly as we work toward a national aquaculture framework agreement.

I look forward to meeting you. I hope you have a great conference and visit to Nova Scotia.

**The Honourable Ronald Chisholm, Minister
Nova Scotia Fisheries and Aquaculture**




NOVA SCOTIA
Fisheries and Aquaculture



**Office of the Minister
Fisheries and Oceans**



**Cabinet du Ministre
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A MESSAGE FROM CANADA'S MINISTER OF FISHERIES AND OCEANS

As Canada's Minister of Fisheries and Oceans, it is my sincere pleasure to welcome you to Halifax for Aquaculture Canada 2006. The speakers featured at this event represent some of the very best this country has to offer.



MESSAGE DU MINISTRE DES PÊCHES ET DES OCÉANS DU CANADA

À titre de ministre des Pêches et des Océans du Canada, c'est avec un réel plaisir que je vous souhaite la bienvenue à Halifax à l'occasion d'Aquaculture Canada 2006. Les conférenciers présents à cet événement font partie de l'élite canadienne en aquaculture.

Canada's new government is committed to building a vibrant and sustainable industry that can succeed in the global marketplace. As well as providing the world with a nutritious food source, aquaculture also delivers economic benefits for thousands of Canadians — aquaculture is quickly emerging as a viable option in places where traditional fishing businesses were often the only significant employers.

DFO supports the important scientific research that is fundamental to our decision-making and to improving the global competitiveness of our industry. Our work with respect to aquatic animal health, integrated multi-trophic aquaculture and genomics showcases Canada's leadership in research and development. Conferences like these allow all of us to share knowledge and collaborate to put this knowledge into practice.

I am very proud that Canada produces some of the highest quality aquaculture products in the world and I look forward to continuing my department's work with the scientific community and realizing the aquaculture industry's full potential.

I wish you a successful and informative conference.

Le nouveau gouvernement du Canada s'engage à créer une industrie dynamique et durable qui peut réussir sur le marché mondial. En plus de fournir dans le monde entier une nourriture riche en protéines, l'aquaculture procure des avantages économiques à des milliers de Canadiens. L'élevage de poisson et de fruits de mer émerge rapidement comme option viable là où les entreprises traditionnelles de pêche ont souvent été les seuls employeurs d'importance.

Le MPO appuie l'importante recherche scientifique qui est fondamentale à nos prises de décisions et qui contribue à augmenter la compétitivité à l'échelle mondiale de notre industrie. Nos travaux en ce qui a trait à la santé des animaux aquatiques, à l'aquaculture multi-tropique intégrée et à la génomique, démontrent que le Canada est un chef de file en recherche et en développement. Des conférences comme celles-ci nous permettent à tous de partager nos connaissances et de collaborer à mettre en pratique ces connaissances.

Je suis très fier que le Canada produise aujourd'hui des produits d'aquaculture de qualité supérieure dans le monde. De plus, j'ai hâte de poursuivre le travail de mon ministère avec la communauté scientifique et de développer l'industrie de l'aquaculture selon son plein potentiel.

Je vous souhaite une conférence réussie et informative.

*The Honourable Loyola Hearn, P.C., M.P.
Minister of Fisheries and Oceans*

*L'honorable Loyola Hearn, C. P., député
Ministre des Pêches et des Océans*



Aquaculture Association of Canada – Lifetime Achievement Award Association Aquacole du Canada – Prix honorifique pour contributions

Tuesday, November 21, 2006

9:30 – 10:00 AM

Location: Commonwealth A Ballroom

Lucien Poirier

Director, Innovation et Technologies, Direction générale des pêches et de l'aquaculture commerciales, MAPAQ



L'aquaculture, la situation du Québec

Le Québec dispose d'une très vaste frange côtière et des réserves très importantes au niveau canadien en eau douce de qualité; il possède également un marché interne relativement intéressant et un accès à une énergie peu dispendieuse. Pourtant son aquaculture ne se développe pas au même rythme que celle des provinces voisines. Les causes sont multiples! Se peut-il que cette situation reflète en partie les intérêts somme toute peu maritime du Québec, le faible poids socio-économique de sa petite industrie des pêches ainsi que le contrecoup des efforts visant l'établissement rapide d'une pisciculture de la Truite arc-en-ciel au voisinage des zones les plus peuplées? Le caractère nordique du Québec, avec ses eaux froides et la présence de glace, la rareté des zones abritées en milieu marin et les règles préventives qui régissent la pisciculture constituent des obstacles importants. Les approches mises de l'avant ces dernières années sont centrées sur l'établissement d'un environnement favorable à son développement durable, sur un maillage accru avec les instances régionales et une collaboration plus intenses avec les partenaires. Ces approches s'appuient sur la résolution de problèmes et l'innovation. Nous sommes conscient que le pari de l'aquaculture doit aussi reposer sur une vision à cours et long terme, sur le développement d'une capacité de bien définir les cibles et de circonscrire correctement les investissements à réaliser. Mais le Québec sera-t-il en mesure d'être patient?

Aquaculture, the Situation in Quebec

Quebec has at its disposal vast coastal regions and freshwater reserves of national importance; it also possesses a relatively interesting internal market and an access to inexpensive energy. However, its aquaculture industry isn't developing at the same rate as neighbouring provinces. The reasons are numerous. Could this situation reflect in part Quebec's lesser interest in maritime matters, the weak socio-economics of its small fishing industry as well as the backlash of efforts to rapidly establish rainbow trout fish farms nearly densely populated areas? Other important obstacles include the northern characteristics of Quebec such as cold water and the presence of ice, the rarity of sheltered marine environments and the preventative laws that govern fish farming. Approaches put forward these last few years are centred on the establishment of an environment favourable to durable development, an increased meshing with regional decision makers and a more intense collaboration with partners. These approaches depend on problem resolution and innovation. We are conscious that the aquaculture efforts should also depend on long and short term vision as well as the development of methods to better define targets and to accurately outline future investments. But will Quebec be patient enough?

Biographical Note

Lucien Poirier a débuté sa carrière dans le secteur administratif québécois des pêches après ses études en biologie à l'Université de Montréal et à l'Université McGill. Il fut le premier biologiste québécois à s'intéresser à la mytiliculture et à la pectiniculture. Depuis 1982, il occupe des fonctions de direction. À ce titre, il a contribué à la conception et à la mise en application d'une offre de service aux pêches et à l'aquaculture favorisant l'établissement de liens entre la recherche et le développement. En aquaculture, son nom est associé au développement de plusieurs services à l'industrie et à la recherche dont, notamment, la Société de recherche et de développement en aquaculture continentale (SORDAC), la Société de développement de l'industrie maricole (SODIM). Au cours de sa carrière, il a



su appliquer avec succès une stratégie reposant sur le partage des priorités d'intervention sectorielle en innovation, la recherche d'effets multiplicateurs des investissements et la réalisation de travaux en partenariat.

Lucien Poirier began his career in the administrative sector of fisheries in Quebec after completing his studies in biology at the University of Montreal and McGill University. Mr. Poirier became the first biologist of Quebec to develop an interest in the culture of mussels and scallops. Since 1982, he has held various administrative roles which have contributed to the conception and the application of fishing and aquaculture services. Subsequently, these services have facilitated the merging of the fields of research and development. Within the area of aquaculture, his name is associated with the development of several services and research initiatives within the industry. More notably, some of these research initiatives have included, the Society of Research and Development in Continental Aquaculture (SORDAC), and the Society for the Development of the Mariculture Industry (SODIM). Over the course of his career, he has adopted with great success a strategy based on the following foundations: the amalgamation of the operations and innovation sectors, the research of the multiplier effect of investments towards the agreed priorities and the importance of working together in partnerships.



Aquaculture Association of Canada – Research Award of Excellence Association Aquacole du Canada – Prix d'Excellence en Recherche

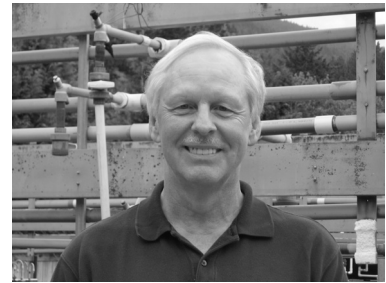
Wednesday, November 22, 2006

9:30 – 10:00 AM

Location: Commonwealth A Ballroom

David A. Higgs, Ph.D.

Head-DFO Fish Nutrition Program (Pacific Region)



Biographical Note

Since August 1975, Dr. Higgs as head of the DFO Fish Nutrition Program based at the West Vancouver Laboratory (presently the DFO/UBC Centre for Aquaculture and Environmental Research), has conducted collaborative projects within DFO and with universities (professors and graduate students) and/or industry that have been directed primarily to (1) improving the cost effectiveness of hatchery and mariculture operations, (2) minimizing organic matter, nitrogen and phosphorus discharge from salmon farms into the environment, and (3) enhancing the flesh quality or consumer acceptance of market-size salmon and sablefish. Major study areas modifying the foregoing goals have included: nutrient and energy requirements; feedstuff digestibility; improvement of fish meal quality; alternate protein, lipid and carotenoid pigment sources to expensive premium quality fish meal and oil and synthetic astaxanthin, respectively; comparisons of the nutrient profiles of farmed and wild BC sources of salmon; development of nutritional strategies to reduce flesh organohalogen concentrations and enhance (n-3) highly unsaturated fatty acid levels for potential human health benefits; nutrition-disease interactions; exercise-nutritional status interactions; nutrition-endocrine interactions; nutrition of non-transgenic versus transgenic salmon; and assessment of the potential nutritive values of salmon prey species and of the energy expenditures of wild Pacific salmon undergoing their spawning migration.



Conference Keynote

Monday, November 20, 2006

9:00 – 10:00 AM

Location: Commonwealth A Ballroom

Challenges to the Aquaculture & Beef Industries in the Areas of Food Safety, Food Quality & Consumer Confidence

Dr. Gary Smith, Ph.D.

University Distinguished Professor, Department of Animal Sciences, Colorado State University



Presentation Synopsis

There are parallels between criticisms directed toward those in the beef industry and those in the fish-farming industry. Unfair, unfounded and "just plain wrong" accusations are made about the beef industry relative to the use of antibiotics and hormones; the potential use of irradiation and genetic engineering, the cruelty and spread of disease associated with confinement rearing; the frequency with which inhumane care/handling occurs; the significance of "higher" residues of chemicals (e.g., pesticides), and; the impropriety of use of dyes, pigments and colorants in consumer products. Examples of the manner in which the US beef industry reacts to such criticism will hopefully be helpful to those in the aquaculture industry.

Biographical Note

Gary C. Smith occupied the Ken and Myra Monfort Endowed Chair in Meat Science at Colorado State University in June of 1990. Previously, he served as Professor (1969-1982) and Head (1982-1990) of the Department of Animal Science at Texas A&M University where he won the Outstanding Teaching Performance Award, the Honor Professor Award, the College of Agriculture Teaching Award, the University Distinguished Teaching Award and the Deputy Chancellor's Award for Team Research.

Gary has won both the Distinguished Research Award and the Distinguished Teaching Award from both the American Society of Animal Science and the American Meat Science Association. He has also been awarded the National Association of Meat Purveyors – Outstanding Educator Award, the National Livestock Grading and Marketing Association – Service Award (three times; in 1979, 1988 and 1995), the Livestock Publications Council – Headliner Award, and was named one of the "25 Who Made a Difference" by Beef magazine. In 1993, he was named a University Distinguished Professor by Colorado State University and a Fellow-In Teaching by the American Society of Animal Science; in 1994 he was named one of six "Industry Innovators" by Meat Marketing and Technology magazine. In 1989, he was named a Distinguished Alumni by College of the Sequoias; in 1996 he received the Alumni Award of Excellence from California State University-Fresno. In 1997, he received the Meritorious Service Award from the Intercollegiate Meat Coaches Association of the American Meat Science Association and the Meat Industry Achievement Award from the American Meat Institute. In 1998, he was the recipient of the "Floyd Forbes Award" for service to the National Meat Association and of the Secretariat of Agriculture of Argentina, Service (to cattle producers and meat packers) Recognition Award. In 1999, Gary received the Top Choice Award from the Colorado Livestock Association and was named the Distinguished Alumnus in Science, Education and Technology by Washington State University. The International Livestock Education Foundation (Houston Livestock Show) inducted him into the International Stockmen's Hall of Fame in 2000. He received a CSU Mortar Board National Honor Society Appreciation Award in 2000. College of the Sequoias honored him with the Outstanding Service Award (Support of Intercollegiate Meat Judging) 2000. In 2000, he was the recipient of the National Cattlemen's Foundation, 2001 Vision Award—Region 5 and the Distinguished Service Award from the U.S. Meat Export Federation. The American Meat Science Association honored him with the R.C. Pollock Award in 2001. He received the Beefmaster Breeders United, Commitment To Excellence Award, 2001. In 2002, he was selected as CSURF Honored Researcher by the Colorado State University



Research Foundation and was listed in ISI Thomson Scientific's 2002 Highly Cited Researchers. In 2004, Beef Magazine named him one of The Beef Top 40. In 2005, he was inducted into the American Hereford Association Hall of Merit

Dr. Smith's research interests include red meat safety, carcass evaluation and grading; composition, quality and palatability of red meat; and, packaging and retailing of red meat. He has published 433 full-length articles in refereed scientific journals and more than 900 other contributions as proceedings, technical reports, etc. Gary served as President of the American Meat Science Association in 1976. For the National Academy of Sciences, he was chairman of the Committee that wrote "Irradiation of Meat and Meat Products" (1979) and a member of the Committee that wrote "Designing Foods" (1988). For the Office of Technology Assessment, he was a member of the Committee that wrote "Packaging and Labeling of Fresh Red Meat" (1974).

Dr. Smith has served on the Board of Directors of Colorado Cattle Feeders Association, as an advisor to the Beef Quality Assurance Advisory Group of the National Cattlemen's Beef Association, and as a member of the Food Marketing Institute/American Meat Institute Meat Marketing Conference Committee. He is on the Scientific Advisory Board of the American Meat Institute, a member of the Western Stock Show Association and the Uniform Retail Meat Identity Standards Committee of the National Cattlemen's Beef Association, is on the Board of Advisors for the American Council on Science and Health, was a member of the National Advisory Committee on Meat and Poultry Inspection for FSIS-USDA, was a member of the Animal Production HACCP Technical Advisory Group for FSIS-USDA, was a member of the Committee for the National Beef Tenderness Plan of the National Cattlemen's Beef Association, was chairman of the National Beef Instrument Assessment Planning Committee for the National Cattlemen's Beef Association and is presently a member of the U.S. Technical Advisory Group For International Organization For Standardization (ISO-9000) Meat And Meat Products Quality Standards for AMS-USDA, was Beef Program Chairman for the 2002 and 2003 International Livestock Congresses and is a member of the Federation of Animal Science Societies' Scientific Advisory Committee (the FASS Committee on Food Safety, Animal Drugs, and Animal Health). He is presently a member of the Boards of Directors of the International Stockmen's Education Foundation, Beefmaster Cattlemen, Food Safety Net Services and IMI Global, and is on Advisory Boards for Research Management Systems and Optibrand. He also serves as a member of the Food Safety Advisory Committee for Packerland Packing Company. Dr. Smith was a member of the US/Japan BSE Working Group in April-July, 2004; a member of the US/Japan BEV Technical Trade Team in October, 2004; and served (2003-2005) as Facilitator for the USMEF/NCBA International BSE Expert Forum. Gary was first listed in Who's Who in Texas (1985), in Science and Engineering (1992), in the West (1998), in America (1999) and in the World (1999). He is a member of the Colorado Livestock Association, Colorado Cattlemen's Association, Mississippi Cattlemen's Association and the National Cattlemen's Beef Association plus holding membership in American Meat Science Association, American Society of Animal Science, Institute of Food Technologists, Sigma Xi, Council for Agricultural Science and Technology, and International Association for Food Protection.



Plenary Session I

Tuesday, November 21, 2006

8:30 – 9:30 AM

Location: Commonwealth A Ballroom

Challenges to Marketing Aquaculture Products

John Sackton

President, Seafood.com

Presentation Synopsis

Sellers of Aquaculture products face two major challenges not shared by sellers of wild fish products: the commodity cycle and the issue of aquaculture purity. First, the overall markets for major aquaculture products will be reviewed: salmon, mussels, cod, tilapia, and others. The talk will investigate whether there is the presence of a commodity cycle or a predictable period of price swings, and what producers can do to sell in this cyclic environment. Secondly, producers have a marketing issue with consumer perception that farmed fish is inferior to wild fish. We will examine the marketing statements being made on this issue, and their impact, and discuss whether certification of aquaculture products is an answer.

Biographical Note

John Sackton, President of Seafood.com and editor and publisher of Seafood.com News, has been active in the seafood industry for over 27 years. He is recognized as one of the top seafood market analysts and his daily seafood commentary is read by thousands in the industry. After 15 years working for global seafood companies lastly as General Manager for Baader North America, the leading manufacturer of fish processing equipment world wide, he founded his own business in 1994 to provide market data, foreign trade information, and price forecasts to the industry. A few years later he founded Seafood.com News with Urner Barry Publications. Seafood.com news is a daily electronic seafood news report that is the most widely read seafood industry news service in North America. Through Seafood.com News, John has written extensively about all aspects of producing, marketing and selling all species of seafood, from warm water shrimp to Alaska salmon and pollock to Canadian snow crab and others. For eight years John has provided independent in-season market reports on crab and shrimp markets to Canadian harvesters and processors in Newfoundland. For the past six years, these bi-weekly reports have adjusted crab ex-vessel prices under bargaining agreements in response to market conditions. This feedback mechanism established through legislation, has contributed to the stability of the crab industry in Newfoundland, and has been well received by buyers and sellers in the U.S. market. In 2005, Sackton was selected to be the industry market analyst and price formula arbitrator for the Alaskan king crab and snow crab. With Northern Shrimp, John has provided a market outlook for the coming year for FFAW and FANL on shrimp each year for the past five years. John has also done studies of processing issues in New Brunswick and Newfoundland. He recently addressed the Canadian Council of Fisheries Ministers on the impact of globalization on Canadian fisheries, the only non-government speaker invited to their meeting. John provides a full range of seafood consulting and speaking services in the areas of price forecasting, market analysis, trade analysis, and data services. He has worked directly with hundreds of seafood companies around the world. He is a graduate of Harvard college in Cambridge, Massachusetts, and has a Masters Degree in Marine Affairs from the University of Rhode Island. John lives and works in Lexington, Massachusetts outside of Boston.



Plenary Session II

Wednesday, November 22, 2006

8:30 – 9:30 AM

Location: Commonwealth A Ballroom

Culturing Quality and Confidence: The Chilean Salmon Cluster Experience

Adolfo Alvial

Director, Salmon Technological Institute, Instituto Tecnológico del Salmón S.A. INTESAL

The Chilean Salmon Farming Industry has shown an impressive evolution in recent years as consequence of its strategic and competitive advantages which have allowed it to successfully overcome the challenge of distant foreign markets, and now has brought Chile to lead salmon farming production along with Norway. Very early in its development the industry tried to promote associative approaches in order to face upstream and downstream challenges. In fact, quality market requirements were faced throughout the development of a pioneer quality seal and almost at the same time launched a Phytoplankton vigilance program which remains in place today. Associative and cooperative views soon allowed the establishment of the Chilean salmon farming association (SalmonChile) and the Technological institute of Salmon (INTESAL, the Technological branch of the association). Presently INTESAL has developed a Vigilance and Management Model which serves the associated companies, involving principal producers and suppliers in the industry. As a result, Environment, Market and Regulations variables are being monitored and Geographic and Good Management Practices tools have been established. Recently in order to strengthen these associative efforts two important Cluster reinforcement Programs have been established: the Integrated Territorial Program, under the INTESAL umbrella; and the Directive Skills Diploma under the Universidad de Chile and SalmonChile association. The first one actively promotes R&D and Innovation initiatives by emphasizing producers-suppliers cooperation, meanwhile the second one cooperates to build qualified human resources for the Salmon Cluster by opening new strategic avenues for the industry.

Biographical Note

Adolfo Alvial is the general manager of the Technological Institute of Salmon (INTESAL), the technological arm of SalmonChile, the Chilean salmon farming industry association. He is also President of the Incubator company INER-Los Lagos, devoted to support new innovative business in the Xth Region of Chile and a member of the Board of Austral Incuba another similar company based in the City of Valdivia, and, since 2001, General Manager of ORBE XXI S.A., a company created to assist the industry and Chilean institutions in the aquaculture, ecotourism and environmental management. He was the founder and EuroChile's partner in the ecotourism company "EcoAustral S.A" and was its general manger from 2000-2002. From 1992-2000 he was manager of the aquaculture and environmental management area in Fundación Chile, which included management of turbot and abalone projects involving technology transfer and the design, installation and operation of the pilot centers. From 1999-2000 he was director of the ecotourism and environmental management area of Fundación Chile. He was also Professor at the Natural Resources and Environmental Management Faculty of the Universidad Nacional Andrés Bello (2001), Associate Professor at the Montemar Institute of Oceanology (the pioneer and oldest marine research station in Latin America), Universidad de Valparaíso (1990-1999) and associate professor in the Marine Science Department of the Universidad Arturo Prat, Iquique, Chile, from 1980-1987. He holds an MBA from the Universidad Adolfo Ibañez Santiago, Chile (2000) and an MSc from Oregon State University in marine resource management (1987).



Registration and Information / Inscription et informations

Registration / Inscription

Registration is located in the Mezzanine of the Westin Nova Scotian Hotel and operates daily as follows:

Sunday November 19, 1:00PM – 8:00PM

Monday November 20, 7:30AM – 5:00PM

Tuesday November 21, 8:00AM – 5:00PM

Wednesday November 22, 8:00AM – 3:00PM

All social function tickets may be obtained from the registration desk.

Entrance to Sessions / Accès aux sessions

Entry to a session or to the trade show will not be permitted without the appropriate Aquaculture Canada '06 or tradeshow nametag.

Notes for Speakers and Posters / Notes pour conférenciers et affiches

Posters –Maritime and Bedford Rooms

Set-up time is Sunday November 19 5:00PM to 7:00PM and Monday November 20 from 8:30AM to 10:00AM.

Presenters are asked to be available at their poster during the Poster Session on Tuesday, November 21 from 2:00 – 4:00PM as well as during morning break periods.

Speakers / oral presenters are asked to provide a copy of their presentation (CD or floppy) to the registration desk by 5PM the evening prior to their scheduled session. All presenters are requested to meet their session chair and AV personnel no less than 30 minutes prior to session commencement.

Program changes will be announced at the beginning of each session and posted in the foyer next to each session room (Commonwealth A Ballroom, Harbour Suites A & B).

Media Room / Salle de média

The Northumberland Room is available for media.

Job Board / Annonces d'emploi et résumés

Notice boards are available for posting résumés and job notices in the Commonwealth Foyer.

Tradeshow

Monday November 20, Trade Show Area, Atlantic Ballroom, 10:00AM – 5:00PM

Tuesday November 21, Trade Show Area, Atlantic Ballroom, 10:00AM – 4:00PM

Student Affairs and Events / Affaires étudiantes

Student Awards – The AAC is pleased to have sponsored travel for ten students to attend the conference and AGM. Thirty four students will compete for Best Oral and Best Poster presentations.

Best Oral Presentation and Best Poster Presentation Awards are sponsored by the Aquaculture Centre, University of Guelph and Aqua Health.

Joe Brown BBQ in support of AAC Students – The proceeds from activities at the BBQ on Monday November 20 go towards the AAC Student Endowment Fund to support student travel to



Aquaculture Canada^{OM} 2006

Aquaculture Canada^{OM} meetings. Students are especially encouraged to attend and participate in the evening's events.

AAC Student VIP Meet and Greet – The purpose of this event on Tuesday November 21 is to present students at the meeting with the opportunity to talk one-on-one with VIPs of the aquaculture industry, federal and provincial governments, and academia. This will provide students who are planning a career in aquaculture an opportunity to make senior level contacts, and get career advice from the seasoned experts.

AAC AGM, Luncheon and Student Presentation Awards – Awards for Best Student Oral and Best Student Poster presentations will be given out during the AGM on Wednesday November 22. Lunch is available for the nominal cost of \$15 (tickets must be purchased by Monday, November 20) and students are encouraged to attend for the Award presentations.

Social Functions / Fonctions

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

President's Reception / Réception du président

Sunday November 19, Commonwealth A Ballroom, 7 - 10 PM. Cash bar.

Sponsored by Atlantech Engineering & Associates, Shurgain, and Future Nets & Supplies Ltd.

Joe Brown BBQ in support of AAC Students / le BBQ aquacole

Monday November 20, Waterfront Warehouse Restaurant, 1549 Waterfront St., Halifax. Tickets are required and must be purchased at the Registration desk by 10AM November 20. 6:30PM cash bar; 7:00PM dinner; 8:30PM jam session, silent auction.

Let's Salsa! Banquet

Tuesday November 21, Commonwealth A Ballroom. 6PM cash bar, 7PM dinner. Tickets are required and must be purchased at Registration desk by November 20.

AAC Annual General Meeting and Luncheon / Assemblée des membres et lunch d'affaires

Wednesday November 22, Atlantic Ballroom, 12:30 - 2 PM. Ticket required and must be purchased at Registration desk by noon November 22.



Industry Tours

The Aquaculture Canada^{OM} 2006 organizing team would like to thank the following companies and site personnel who have opened their facilities and have given of their time to provide tours for the conference delegates.

All tours are on November 23 and will start from the foyer of the Westin Nova Scotian Hotel. Tour tickets can be purchased at the AC06 registration desk.

Tour 1: South Shore Alternate Species Tour

Tour 1 will leave the Westin at 0700 and will return at approximately 2000.

Tour Guide: Darrell Harris, Fisheries and Oceans Canada

- Scotian Halibut Ltd., Clark's Harbour
- Scotian Halibut Ltd., Lower Woods Harbour
- Atlantic Abalone 2000 Ltd., Volger's Cove

Tour 2: Advocate – Truro Recirculation Facility Tour

Tour 1 will leave the Westin at 0730 and will return at approximately 1900.

Tour Guide: Andrew Bagnall, Nova Scotia Fisheries and Aquaculture

- Canaqua Seafoods Ltd., Advocate
- Millbrook First Nation Fish Culture and Hydroponics, Millbrook

Trade Show

The following companies are displaying booths in our trade show. Please make sure you take time to stop by to see their products and services!

- | | |
|--|---|
| • Aquaculture Engineering Group Ltd | • Inventive Marine Products Ltd |
| • Atlantech Companies | • Maritech Software Inc. |
| • Bouctouche Bay Industries Ltd | • Memorial University of Newfoundland Aquatic Health Services |
| • Corey Feed Mills Ltd | • Millennium Marine |
| • Detroit Diesle Allison Canada East | • National Seafood Sector Council |
| • Dura-Tech Industrial & Marine Ltd | • Northeast Equipment Ltd |
| • Entreprises Shippagan Ltée | • Nova Scotia Agricultural College |
| • Fisheries & Oceans Canada | • Nova Scotia Fisheries and Aquaculture |
| • GMG Fish Services Ltd | • Polysteel Atlantic Ltd |
| • Go Deep International | • Rainbow Net & Rigging Ltd |
| • Grand Bank Development Corporation | • RPC |
| • Hoskin Scientific Ltd | • TT Canada Inc (Trace Tracker Canada) |
| • Hydraulic Systems Ltd | |
| • Institute for Coastal Research -
Malaspina University-College | |



Program Outline / Sommaire du Programme Aquaculture Canada 2006

Day 1 – Sunday, November 19, 2006

1500-1800	Tradeshow Exhibitors Set-Up	Atlantic Ballroom
1300-2000	Registration	Mezzanine
1900-2100	President's Reception	Commonwealth A Ballroom

Day 2 – Monday, November 20, 2006

0730-1930	Registration	Mezzanine
0830-1000	Plenary Session	Commonwealth A Ballroom
1000-1700	Trade Show	Atlantic Ballroom
1000-1600	Poster Session	Bedford and Maritime Rooms
1020-1700	Technical Sessions	Commonwealth A, Harbour Suites A and B
1100-1430	AquaPort Meeting and Luncheon (invitation only)	Commonwealth B
1830-2300	Joe Brown BBQ in Support of AAC Students Bar Open 1830 Dinner 1900 Silent Auction and Jam Session 2030	Waterfront Warehouse Restaurant



Day 3 – Tuesday, November 21, 2006

0700-0830	AAC Industry Breakfast (invitation only)	Lunenburg Room
0800-1600	Registration	Mezzanine
0830-1000	Key Note Speaker and Lifetime Achievement Award	Commonwealth A Ballroom
1000-1600	Trade Show	Atlantic Ballroom
1000-1600	Poster Session	Bedford and Maritime Rooms
1020-1700	Technical Sessions	Commonwealth A, Harbour Suites A and B
1630-1800	AAC Student Meet and Greet	Commonwealth B
1800-2300	Lets Salsa No host bar 1800 Dinner 1900	Commonwealth A Ballroom

Day 4 – Wednesday, November 22, 2006

0800-1500	Registration	Mezzanine
0830-1000	Key Note Speaker and Research of Excellence Award	Commonwealth A Ballroom
0900-1200	Poster Session	Bedford and Maritime Rooms
1020-1700	Technical Sessions	Commonwealth A, Harbour Suites A and B
1230-1400	AAC AGM Luncheon and Student Awards	Atlantic Ballroom

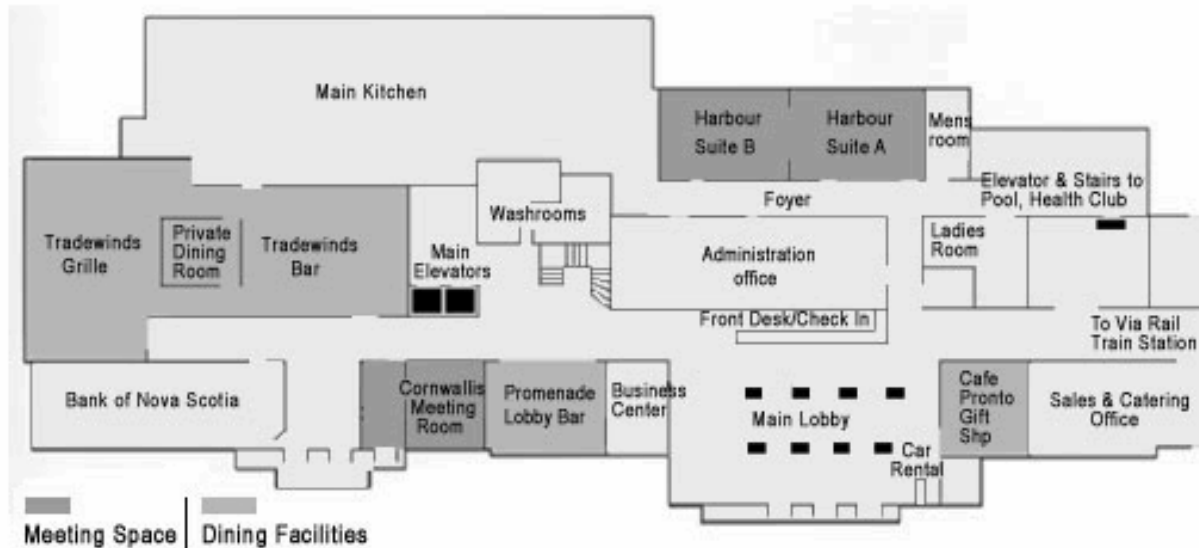
Day 5 – Thursday, November 23, 2006

0700-2000	Tour 1 South Shore Alternate Species	Leaves from the foyer of the Westin Nova Scotian Hotel
0730-1900	Tour 2 Advocate Truro Recirculation	Leaves from the foyer of the Westin Nova Scotian Hotel

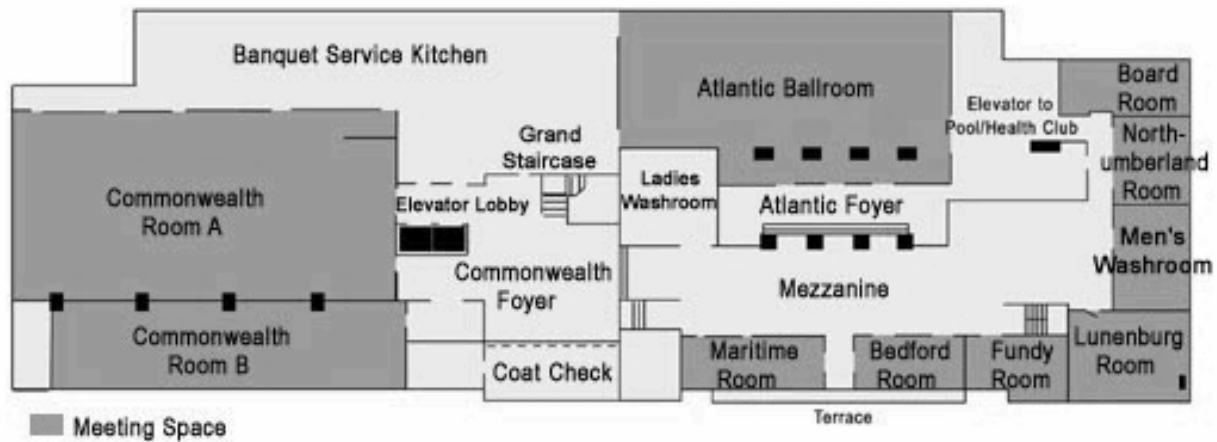


Floor Plan

LOBBY LEVEL: Ground Floor



CONFERENCE LEVEL: Second Floor





Speakers Outline and Abbreviated Titles – Aquaculture Canada^{OM} 2006

Liste des conférenciers et titres des présentations

Monday November 20, 2006 – Morning

8:30	Opening Session – Commonwealth A		
	C. Hendry, President, AAC B. Muise, Executive Director, Aquaculture Assoc. Nova Scotia R. Chisholm, Minister, Nova Scotia Fisheries and Aquaculture P. Murphy, Councillor, Halifax Regional Municipality		
9:00	Conference Keynote Dr. Gary Smith "Challenges To The Aquaculture & Beef Industries In The Areas Of Food Safety, Food Quality & Consumer Confidence"		
10:00	HEALTH BREAK	HEALTH BREAK	HEALTH BREAK
	Commonwealth A	Harbour Suite A	Harbour Suite B
10:20	Alternate Species	Shellfish Culture	Ecosystem Health
	10:20 - Le Francois: "Wolffishes, custom-fit marine fish species for cold-water aquaculture: slow train coming"	10:20 - Drapeau: "Association between longline design and mussel productivity in Prince Edward Island, Canada"	10:20 - Moccia: "Chemical and Physical Properties of Trout Feces"
	10:40- **Dupont Cyr: "Compression of the reproduction cycle of Wolffish (Anarhichas minor & A. Lupus)"	10:40 - Gagne: "Effect of addition of Rhodomonas salina in diet of Pecten maximus"	10:40 - Reid: "IMTA in the Bay of Fundy: Modelling salmonid nutrient loading"
	11:00 - **Gaudreau: "Impacts of hybridization of spotted and atlantic wolffish: fundamental and applied study"	11:00 - Girault: "Post harvest gaping of mussels : influence of season and site of harvest"	11:00 - Page: "DEPOMOD in relation to salmon farming in the southwest New Brunswick area of the Bay of Fundy"
	11:20 - **Leadbeater: "Comparison of the Biochemical Composition of Shortnose Sturgeon"	11:20 - **Lachance: "Influence of different factors on the attachment strength of blue mussel from suspended culture"	11:20 - **Salazar-Hermoso: "Evaluating Stable Isotopes for the Identification and Quantification of Aquaculture Solids"
	11:40 - **Theriault: "Effect of varying dietary levels of essential fatty acids on lobster postlarvae"	11:40 - **Lachance-Bernard: "Self-thinning in blue mussel populations reared on self-regulated collectors"	11:40 - Francis: "Revitalising our Environmental Resources for Sustainable Aquaculture"
	12:00 - Butts: "Artificial insemination in winter flounder: determination of the optimal spermatozoa to egg ratio"	12:00 - Lander: "Using carbon and nitrogen isotopes as indicators of organic matter source in Mytilus edulis IMTA"	
12:20	LUNCH (not provided)		



Monday November 20, 2006 – Afternoon

	Commonwealth A	Harbour Suite A	Harbour Suite B
13:40	Invasive Species	Shellfish Culture Continued	Aquaculture Development, Policy and Regulation
	13:40 - Thomas Landry: Introduction to AIS Terminology	13:40 - Myrand: "Grow-out of soft-shell clams, Mya arenaria, before seeding"	13:40 - Fraser: "Traceability - A necessary evil or a business opportunity?"
	14:00 - TBA: Monitoring: Review of the monitoring efforts and results form Atlantic, Central and Pacific Zones.	14:00 - Myrand: "Development of open-sea culture of mussels in Iles-de-la-Madeleine (Québec): four years later"	14:00 - Ridler: "Prospective Analysis of Aquaculture Development; the Delphi Method"
	14:20 - TBA: Control: Strategies, tools and legislation to manage the spread and introduction of AIS.	14:20 - **Power: "Growth, Feeding and Motile Behaviour in the Blue Mussels in the Presence of the Starfish"	14:20 - Grant: "Management of Aquaculture Site Selection via Regional Habitat Classification: Bridging Science and Policy"
	14:40 - TBA: Research: Research programs (i.e. CAISN) and contributed presentations	14:40 - Redjah: "Physiological response of juvenile american oysters, Crassostrea virginica, to thermal changes"	14:40 - Ridler: "Enhancing sustainability of salmon culture in Canada: a socio-economic analysis of IMTA"
	15:00 - TBA: Research: Research programs (i.e. CAISN) and contributed presentations	15:00 - **Trottet: "Modelling the carrying capacity of semi-enclosed lagoons for shellfish farms"	15:00 - Jayaraman: "Small-Scale Aquaculture for Livelihood Development of Tsunami-hit Fisherfolk in India"
	15:20 - TBA: Treatment and mitigation: Recent advancement on treatment and mitigation	15:20 - **Liutkus: "Development of a Submersible Longline System for Blue Mussel (<i>Mytilus edulis</i>) Culture"	Current Topics in Aquaculture
	Discussion	15:40 - Karimzadeh: "An investigation of dietary calcium on survival, moulting and body composition of juvenile crayfish"	15:20 - **Conroy: "Performance Characteristics of the Horizontal Moving-Bed Biofilter"
		16:00 - **Mamoser: "Shellfish Industry Response to Site Assessment Needs and Ecosystem-based Management Approach"	15:40 - Couturier: "Velocity Profiles in Multi-drain Circular Tanks"
			16:00 - **Ramachandram: "Land-based aquaculture solids management using bio-treatment technology"
			16:20 - Mehrennezhad: "Culture and purification of <i>Dunaliella salina</i> of Urmia Lake"
			16:40 - Mehrennezhad: "Evaluation of hatching percentage and hatching efficiency of <i>Artemia urmiana</i> cysts"


Tuesday November 21, 2006 – Morning

8:30	Plenary I: John Sackton		
	"Challenges to Marketing Aquaculture Products"		
9:30	Honourary Lifetime Achievement Award Lucien Poirier		
10:00	HEALTH BREAK	HEALTH BREAK	HEALTH BREAK
	Commonwealth A	Harbour Suite A	Harbour Suite B
10:20	Industry Marketing & Communications	Atlantic Cod Culture	Finfish Health
	10:20 - Butte: "Building Consumer Confidence: Consumer Perceptions of Farmed Salmon"	10:20 - Lush: "An egg by any other name....a comparison of gamete collection methods for Atlantic cod (Gadus morhua) broodstock"	10:20 - Puvanendran: "Possible causes of vertebral deformity in Atlantic cod larvae"
	10:50 - Swartz: "Benefits Versus Risks of Seafood – Where Do We Stand?"	10:40 - **Kellett: "Influence of lighting regime on the sexual maturation of cage cultured Atlantic cod (Gadus morhua)"	10:40 - **Bruce: "Effect of Temperature Stress on Clinical Infections of Nodavirus in Atlantic Cod (Gadus morhua)"
	11:20 - Sackton: "Market reaction to customer perceptions of aquaculture products"	11:00 - Tibbetts: "Utilization of plant protein sources by juvenile Atlantic cod (Gadus morhua L.)"	11:00 - **Chavan: "Impact of Heavy Metals on Fresh Water Fish Cirrhinus mrigala in Relation to Oxygen Consumption"
	11:50 - Walling: "Farmed Salmon: How an ENGO Coalition Frames the Salmon Farming in B.C."	11:20 - Trippel: "Use of continuous light and triploidy to control sexual maturation in farmed Atlantic cod (Gadus morhua)"	11:20 - Chang: "Phytoplankton early warning approaches for salmon farms in southwestern New Brunswick"
	Discussion	11:40 - **Clarke: "Lipids and Fatty Acids as Indicators of Egg and Larval Viability in Atlantic Cod (Gadus morhua)"	11:40 - Martin: "Industry enumeration, early warning and hind-casting of harmful phytoplankton blooms"
		12:00 - Garber: "Initial performance evaluation of cultured Atlantic cod (Gadus morhua) families"	12:00 - Burrige: "Lethality of Microalgae to Farmed Atlantic Salmon"
		Discussion	Discussion
12:30	LUNCH (not provided)		



Tuesday November 21, 2006 – Afternoon

	Commonwealth A	Harbour Suite A	Harbour Suite B
14:00	R&D Tax Credit Program	Finfish Culture	Finfish Health Continued
	14:00 - Arsenault: "SR&ED Tax Program: Fostering Scientific and Technological Innovation in Canada"	14:00 - Fesschaye: "Application of Microsatellite DNA Markers for Optimal Design of Nile Tilapia Breeding Program"	14:00 - Easy: "A Case For Mucus: An Essential Component In Innate Immunity In Fish"
	14:20 - Whey: "Are You Getting the R&D Tax Credit You Deserve? SR&ED Best Practices In Aquaculture"	14:20 - **Pelletier: "Life Cycle Measures of Sustainability in Salmon Aquaculture"	14:20 - George: "Survival on a Deformed <i>Oreochromis Niloticus</i> in an Intensive Water Recirculating System"
	14:40 - TBA: "Perception and Use of the SR&ED Tax Incentive from Industry"	14:40 - **O'Keefe: "Temperature preference of diploid and triploid brook trout (<i>Salvelinus fontinalis</i>)"	14:40 - Azizpour: "Probiotics and their role in disease resistance"
	Discussion	15:00 - **Chaisson: "Hormonal Sex Reversal in Arctic Charr (<i>Salvelinus alpinus</i>)"	15:00 - **Bagheri: "Effects of probiotics on growth, survival and gut microbial load of rainbow trout"
15:20	Challenges to Marine Aquaculture – Aquaculture in Cold Oceans	15:20 - George: "Early Rearing and Development of <i>Oreochromis niloticus</i> , in the Sudan"	Environmental Management
	15:20 - Fletcher: "Fish antifreeze proteins: Their potential value to sea cage aquaculture"	15:40 - Walker: "Salmon breeding in Atlantic Canada – An Update"	15:20 - Grant: "Introduction"
	15:40 - Audet: "Finfish aquaculture management and biological adaptations to cold water"	16:00 - Abdollahpour Biria: "Early development of the <i>Barbus capito</i> "	15:25 - Reid: "Freshwater finfish cage culture environmental management"
	16:00 - Doiron: "Overwintering methods of long line systems for shellfish"	16:20 - Abdollahpour Biria: "Research on artificial spawning of <i>Barbus capito</i> and its larvae-culture"	15:45 - McGarry: "Marine Finfish Cage Culture Environmental Management"
	Discussion	Discussion	16:05 - Cranford: "Shellfish culture environmental management: Assimilative capacity of mussel culture."
			16:25 - TBA: Linking animal health and environmental health – Activities of the new AquaNet node
			Discussion


Wednesday November 22, 2006 – Morning

8:30	Plenary II: Adolfo Alvial "Culturing Quality and Confidence: The Chilean Salmon Cluster Experience"		
9:30	Research Award of Excellence David Higgs		
10:00	HEALTH BREAK	HEALTH BREAK	HEALTH BREAK
	Commonwealth A	Harbour Suite A	Harbour Suite B
10:20	Genomics in Aquaculture	National Code System	Orchestrating Aquaculture Research and Development
	10:20 - Dennis: "Aquaculture Genomics: Building a globally-competitive Canadian aquaculture industry."	10:20 - Bedellion: "Why the Need for Codes?"	10:20 - Parsons: "Perspectives and overview of Canadian aquaculture research and innovation"
	10:40 - Bowman: "Cod genomics in Atlantic Canada"	10:40 - Ford: "Government perspective – Smart Regulation and Codes"	10:40 - Taylor: "Collaborative R&D: What Works, What Doesn't"
	11:00 Rise: "Salmonid EST database and DNA microarrays: tools for functional genomics research"	11:00 - Rideout: "National Industry Perspective – Update on the National Code System"	11:00 - Alvial: "Chilean Salmon Cluster: Evolution and Prospects"
	11:20 - Brown: "From Sequence to Sickness: Genomic Approaches to Aquatic Disease Management".	11:20 - Stevenson: "West coast perspective – Development in BC Finfish and Shellfish"	11:20 - Discussion 1 - Identify Issues
	11:40 - Reith: "Pleurogene: Genomics for the production of Atlantic halibut and Senegal sole."	11:40 - Couturier: "East coast perspective – Development in Atlantic Canada"	11:40 - Anderson: "Experiences of the Canadian Agri-food Research Council"
	Discussion	12:00 - Kearney: "Farmer's Experience and Perspective"	11:55 - Smith: "Perspective from the Canadian Aquaculture Industry on RD&C"
			12:10 - Vaillancourt: "SODIM's model for aquaculture research and innovation in Québec"
12:30	AAC AGM Luncheon and Student Awards Atlantic Ballroom		



Wednesday November 22, 2006 – Afternoon

	Commonwealth A	Harbour Suite A	Harbour Suite B
14:00	Challenges to Marine Aquaculture – Integrated Multi-Trophic Aquaculture	Animal Health and Welfare	Orchestrating Aquaculture Research and Development
	14:00 - Chopin: "Rationale and Kelp Cultivation as the Inorganic Extractive Component of the System"	14:00 - Veniot: DFO: "Health monitoring of American oysters, <i>Crassostrea virginica</i> ,	14:00 - Meaney: "Provincial Perspective on Enhancing Aquaculture Research and Innovation in Canada"
	14:20 - Cross: "IMTA and the Pacific SEA-Lab Initiative"	14:20 - Mills: "Health Management Practices: Marine Harvest"	14:15 - Warris: "Linking research to industry needs for development and innovation"
	14:40 - Robinson: "Mussel Cultivation as the Organic Extractive Component and Evolution of the System"	14:40 - Lumsden: "Viral hemorrhagic septicemia virus type IV in the Great Lakes."	14:30 - Audet: "Réseau Aquaculture Québec: Building bridges with our local organizations and the Québec industry"
	15:00 - Swift: "A Multi-trophic Approach in Freshwater Land-based Salmon Farming in B.C."	15:00 - Moccia: "I Swim Therefore I Am? Issues On the Welfare of Farmed Fish."	14:45 - DeJager: "Mobilizing Knowledge: AquaPort and the AAC Science Advisory Forum"
	Challenges to Marine Aquaculture – Open Ocean Aquaculture		15:00 - 16:00 - Discussion 2 - Strategies and Solutions
	15:20 - Jackson: Introduction	15:20 - Soanes: "Zebrafish: a model organism for studying host-pathogen interaction in cultured fish species."	
	15:25 - Jackson: "US Cooperation in Open Ocean Developments"	15:40 - Pedersen: "National Aquatic Animal Health Program: current status and direction"	Shellfish Health
	15:45 - Chambers: "Recent developments in the US"	16:00 - MacCallum: "British Columbia Shellfish Aquatic Animal Health Program"	16:00 - Belvin: "Health survey of marine bivalves from cultured and experimental sites in the province of Quebec"
	16:05 - Bridger: "Recent Development in Atlantic Canada"	16:20 - Beattie: "Update: ISA"	16:20 - Genard: "Bacterial challenge on oyster larvae (<i>Crassostrea Virginica</i>): biochemical and genomic reponses"
	Discussion		16:40 - Frechette: "Studies of the abundance of the caprellid on mussel spat collectors and its effect on mussel spat"



Sessions and Abstracts – Aquaculture Canada^{OM} 2006

Opening and Welcome

Monday November 20, 2006

8:30 – 9:00 AM

Location: Commonwealth A Ballroom

Chair: C. Hendry (President, Aquaculture Association of Canada)

Chris Hendry, President, Aquaculture Association of Canada

Brian Muise, Executive Director, Aquaculture Association of Nova Scotia

Honourable Ron Chisholm, NS Minister of Fisheries and Aquaculture

Councillor Patrick Murphy, Halifax Regional Municipality



Conference Keynote

Tuesday, November 21, 2006

9:00 AM – 10:00 AM

Location: Commonwealth A Ballroom

9:00 G. Smith

Challenges to the Aquaculture & Beef Industries in the Areas of Food Safety, Food Quality & Consumer Confidence



Alternate Species – Contributed Papers

Monday, November 20, 2006

10:20 AM - 12:20 PM

Location: Commonwealth A Ballroom

Chair: Nathalie Le-Francois (Université du Québec à Rimouski)

10:20 N.R. Le François

Wolffishes, custom-fit marine fish species for cold-water aquaculture: slow train coming.

10:40 B.A. Dupont Cyr

Compression of the reproduction cycle of wolffish (*Anarhichas minor* & *A. lupus*).

11:00 C.M. Gaudreau

Impacts of hybridization of spotted and Atlantic wolffish: fundamental and applied study.

11:20 S. Leadbeater

Comparison of the biochemical composition of shortnose sturgeon (*Acipenser brevirostrum*) eggs from wild and captive sources.

11:40 I. Theriault

Effect of varying dietary levels of essential fatty acids on growth, survival and behavioural responses of competent lobster postlarvae: ecological implications for enhancement.

12:00 I.A.E. Butts

Artificial insemination in winter flounder: determination of the optimal spermatozoa to egg ratio.

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

Wolffishes, custom-fit marine fish species for cold-water aquaculture: slow train coming.

N.R. Le François*

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In order to develop new aquaculture productions at commercial scale, increased knowledge of the interaction between rearing environment, juvenile quality, growth performance and fish welfare is clearly warranted. Apart from those concerns, to bring a novel species to commercialization unquestionably requires the adoption of a global strategy that covers marketing, applied research and above all a strong collaborative approach. In order to accelerate this process, strategic funding and true collaborative approach from all levels of intervention are crucial. A brief outlook of Norwegian and Icelandic involvement in the wolffish adventure will be presented. Actual and future wolffish R&D tasks and needs will be briefly presented, as well as the rationale behind the status of the cold-water aquaculture activity in Québec and Newfoundland, Canada.



Compression of the reproduction cycle of wolffish (*Anarhichas minor* & *A. lupus*).

B.A. Dupont Cyr^{*1}, N.R. Le François^{2,3}, R. Roy⁴ and H. Tveiten⁵

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⁵Fiskeriforskning, Muninbakken, Breivika, Tromsø, Norway

Wolffish is a new mariculture species of strong interest in the east of Canada. One of the major constraints to the emergence of a new mariculture species is the year-round supply of high-quality juveniles which could be partly resolved through the obtention of two production per year coupled to the enhancement of gametes quality. It appears that photoperiod and temperature are two signals that play an important role in maturation of wolffish. The objectives are 1) to use photoperiod to compress the reproduction cycle of wolffish 2) to characterize the annual sexual steroid profile, and 3) to quantify the effects of photoperiod manipulation on gamete quality, growth and appetite. Each month, blood samples and morphological data are collected for each individual fish. Sexual maturation of female wolffish is monthly monitored through oocyte diameter by echography. Further analysis of the plasma will include the evaluation of vitellogenin and sexual steroid (Testosterone, 11-ketotestosterone and 17- β -oestradiol), will be assayed by ELISA. Initially, the reduction of the cycle may affect gamete quality and reduce fertilization rate. We expect to obtain a compression of the reproduction cycle from 12 to 8 months with a high reproduction performance after 2 years.

Impacts of hybridization of spotted and atlantic wolffish : fundamental and applied study.

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Our research concentrates on comparison of juveniles of spotted and Atlantic wolffish hybrids and parental species. Four aspects are studied: 1) growth performance 2) viability 3) aerobic capacities development 4) geometric morphometrics. On a fundamental level, this project brings new knowledge on functional conservatism in mitochondrial evolution. Hybridization may cause metabolic limitation at the level of mitochondrial catalytic capacity, because of the interaction of nuclear gene products with mitochondrial gene products. Different physiological determinants such as proteins and lipids oxidation and enzymes involved in the mitochondrial electron transport system and aerobic energy metabolism will be used to assess what can limit hybridization between these two species. On the application level, hybrids in aquaculture can improve performance and output by increasing heterosis ("hybrid vigor") and aquaculture fitness. Growing trials under two temperatures (8°, 10°C) were conducted in spring 2006 in a recirculation water system. RNA-DNA ratio will be calculated as growth indicator in addition to periodic growth assessment and monitoring of mortality.



Comparison of the biochemical composition of shortnose sturgeon (*Acipenser brevirostrum*) eggs from wild and captive sources.

S. Leadbeater^{*1}, S.P. Lall² and M.K. Litvak¹

¹Department of Biology and Centre for Coastal Studies and Aquaculture, University of New Brunswick Saint John, Saint John, NB, Canada, E2L 4L5

²Institute for Marine Biosciences, National Research Council of Canada, Halifax, NS, Canada, B3H 3Z1

Captive-held shortnose sturgeon are being used as broodstock for aquaculture development in New Brunswick. Unfortunately, there are no diets developed specifically for this species since little information is available on their nutritional requirements. Thus these fish are fed diets based on formulations developed for salmonids. The effect of captivity on oocyte quality, either due to dietary factors, or environmental factors is unknown. This is particularly important because poor conditions may not only lead to poor larval quality and survival, but most importantly poor caviar quality which is the primary commercial end product of sturgeon aquaculture. Unfertilized eggs were collected from wild shortnose sturgeon caught during the spawning run in the lower Saint John River, and a captive group held by the University of New Brunswick. Biochemical analysis was used to compare egg “condition” to assess the potential effects of salmonid formulations for sturgeon egg quality. Mineral, fatty acid, amino acid, and proximate composition of the eggs were determined. In this presentation, the differences and similarities in egg characteristics will be discussed in relationship to published feed ingredient information and environmental conditions.

Effect of varying dietary levels of essential fatty acids on growth, survival and behavioural responses of competent lobster postlarvae: ecological implications for enhancement

Isabelle Thériault^{*1} and Fabrice Pernet²

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The low recruitment of lobster postlarvae (*Homarus americanus*) in the Northumberland Strait during the last years has promoted the development of juvenile enhancement program which relies on hatchery production of postlarvae. This study examines the effect of varying dietary levels of essential fatty acids (EFAs) on growth, survival and lipid composition of lobsters during their early ontogeny. It also investigates the effect of some of the tested diets on the behavioural response of postlarvae to odour plume and shelter selection. Lobsters were fed three Artemia-based diets (live, frozen or flakes), an Artemia replacement (Artemac®) or a ternary mixture (frozen and flakes Artemia, and Artemac) from egg to postlarvae. The top-performing diets in term of growth were: live > frozen > ternary mixture = flakes > Artemac. In a Y-maze apparatus, arm selection of lobster was not influenced by the presence of the predator irrespective of the diet tested. Surprisingly, lobster fed the ternary mixture and live Artemia low in EFAs were a lot more active compared to those fed Artemac, a commercial formulation rich in EFAs. Implications of larval nutrition in the hatchery on enhancement success will be discussed.



Artificial insemination in winter flounder (*Pseudopleuronectes americanus*): determination of the optimal spermatozoa to egg ratio.

Ian A.E. Butts*, Paymon Roustaian and Matthew K. Litvak

Department of Biology and Centre for Coastal Studies and Aquaculture, University of New Brunswick, Ganong Hall, P.O. Box 5050, Saint John, New Brunswick, E2L 4L5, Canada

Artificial fertilization has long been used for winter flounder (*Pseudopleuronectes americanus*) research and aquaculture, yielding high fertilization and hatch success rates. However no research has been conducted on the number of sperm required to fertilize a winter flounder egg. This has both ecological and aquacultural implications. For ecology we are curious to know about reproductive strategies and for aquaculture we need to develop sperm/genome banks for this and other species under development. Sperm held in these banks will be in limited supply and therefore a valuable resource not to be wasted. Thus the objective of this research was to determine the optimum sperm density for successful artificial insemination of winter flounder in the laboratory. Egg batches from five females were each crossed with sperm from three different males. For each parental combination we tested spermatozoa: egg ratios that ranged from 23:1 to 4.9×10^6 :1. Regression analysis suggests that 20,000 spermatozoa is the optimal quantity required to fertilize a winter flounder egg. Results of this presentation will be discussed with reference to the long-term sustainable development of this species for aquaculture (*i.e.* genome banking).



Shellfish Culture – Contributed Papers

Monday, November 20, 2006

10:20 AM - 12:20 PM

Location: Harbour Suite A

Chair: Terralynn Lander (University of New Brunswick, Saint John)

10:20 A. Drapeau

Association between longline design and mussel productivity in Prince Edward Island, Canada.

10:40 R. Gagné

Effect of addition of *Rhodomonas salina* in diet of *Pecten maximus*.

11:00 L. Girault

Post harvest gaping of mussels: influence of season and site of harvest.

11:20 A.-A. Lachance

Influence of different factors on the attachment strength of blue mussel (*Mytilus edulis*) from suspended culture, in the Magdalen Islands (Quebec, Canada).

11:40 M. Lachance-Bernard

Self-thinning in blue mussel populations reared on self-regulated collectors.

12:00 T.R. Lander

Using carbon and nitrogen isotopes as indicators of organic matter source in the diet of *Mytilus edulis* in integrated multi-trophic aquaculture systems.

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



Association between longline design and mussel productivity in Prince Edward Island, Canada

A. Drapeau^{1*}, L. A. Comeau², T. Landry², H. Stryhn¹ and J. Davidson¹

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²Department of Fisheries and Oceans Canada, Gulf Fisheries Centre, 343 University Avenue, P.O. Box 5030, Moncton, New Brunswick, E1C 9B6, Canada

The first objective of this study was to document the design of subsurface longlines used for the farming of blue mussels (*Mytilus edulis*) in Prince Edward Island (PEI), Canada; the second objective was to identify possible associations between longline design and mussel growth. In 2003, SCUBA divers visited 54 farms distributed in 16 culture embayments; they measured the spacing between longlines and the spacing between individual socks attached to longlines; they also sampled one-year-old mussels for the determination of the shell length, condition index, and sock weight. Longline configuration varied across PEI, with the following range of values: 1.2 to 3.0 m for sock length, 1.5 to 29.5 m for longline spacing, 26.4 to 62.4 cm for sock spacing, and 6.2 to 179.9 socks/100 m² for stocking density at the farm scale. A negative correlation was found between stocking density at the farm scale and total farming area at the bay scale, suggesting that growers adjusted husbandry in relation to the surrounding level of farming activity. In one major culture bay, Tracadie Bay, measurements were repeated over a three-year period (2002-2004) and a 30% (+11 cm) sock spacing increase was detected. Multiple regression analyses identified sock spacing as the only explanatory variable correlated with mussel weight in Tracadie Bay. The model suggests that an 11-cm increase in sock spacing can lead to an 18% weight gain for pre-market mussels (~ 34 mm), the size group investigated in the study. However, this correlation between sock spacing and sock weight was tenuous over the three year study period, showing up only in 2002. A similar correlation was found between sock spacing and condition index, although only in 2004. We conclude by suggesting that close spacing of mussel socks can negatively affect mussel yield, although not consistently.

Effect of addition of *Rhodomonas salina* in diet of *Pecten maximus*

Gagné R.^{*1}, R. Tremblay¹, F. Pernet², P. Miner³, J-F. Samain³ et F. Olivier⁴.

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Overfishing of several scallop populations has promoted the development juvenile enhancement programs, which rely on hatchery production of scallop. However, bivalve larvae often experience high mortalities (1) during their larval development due to nutritional deficiencies and (2) during the juvenile stage due to a reduced attachment strength on collectors. This study determines whether the addition of *Rhodomonas salina* to a standard hatchery diet is effective in increasing postlarval production by reducing nutritional deficiencies and increasing attachment strength of scallops. Scallops fed *R. salina* showed an increase in growth and survival of larvae concomitantly with an increase in 20:4n-6 and a decrease in two other essential fatty acids (22:6n-3 and 20:5n-3). Furthermore, scallops fed *R. salina* showed a reduced attachment strength compared to those fed the standard hatchery diet, presumably reflecting the change in fatty acid composition of the diet. This study is the first to show a correlation between fatty acid nutrition and attachment strength in a marine bivalve.



Post harvest gaping of mussels : influence of season and site of harvest

L. Girault*, M.J. Leblanc and M.L. Larrivée

Centre Collégial de Transfert de Technologie des Pêches, P.O. Box 220, Grande-Rivière, QC G0C 1V0

Cultured mussels often open their valves widely after processing. This “gaping” behavior can severely hinder marketing, especially when mussels are displayed for sale in fish markets. We investigated the influence of site and season on gaping of mussels from Gaspé (GP), Baie des Chaleurs (BC) and Magdalen Islands (IDM), during spring and fall of 2005. Gaping was evaluated seven times, from harvest on to 14 days after processing (D+14), by discriminating mussels that: i) closed upon contact (B1) ; ii) closed only upon immersion in freshwater (B2) and iii) never closed, considered as dying (M). Results show that mortality M and B2 gaping are high during spring and decrease until a minima is reached in October. These parameters are strongly correlated, though B2 occurs mostly after processing and peaks at D+4, while M becomes significant between D+7 and D+14, depending on site and season. B1 gaping is also a transient behavior, usually culminating at D+4 and disappearing before mortality sets in. However, B1 is nearly unaffected by seasonal variations, with only a slight increase in October, and this gaping is clearly unrelated to mortality. Similar trends are observed on the three sites, though IDM mussels have the longest shelf life.

Influence of different factors on the attachment strength of blue mussel (*Mytilus edulis*) from suspended culture, in the Magdalen Islands (Quebec, Canada)

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The suspension culture of mussels in sleeves is possible because they produce byssal threads that attach themselves to the culture substratum. However, we have observed that mussel's attachment strength is variable in time. That may lead to passive losses of mussels by fall-offs from the sleeves and thus to substantial decreases in yield. Therefore it is important, for mussel farmers, to understand the factors that might affect this variation. There has been some studies on attachment strength of mussels in the intertidal zone but none has ever examined mussels in suspension culture. In the present study the variation in attachment strength of 2-yr-old mussels was measured weekly, from late May to mid-October, on sleeves from the Havre-aux-Maisons lagoon, Magdalen Islands. Attachment strength will be discussed in relation with environmental parameters (temperature, food availability, wind and current velocity and direction, wave's height, turbulence) and physiological conditions like reproduction. Spawning and water turbulence seem to have a significant impacts on the attachment strength of mussels.



Self-thinning in blue mussel populations reared on self-regulated collectors

M. Lachance-Bernard^{*1,2}, M. Fréchette², J.H. Himmelman¹

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²Ministère des Pêches et des Océans, Institut Maurice-Lamontagne, 850 Route de la Mer, Mont-Joli, Québec, CP. 1000, G5H 3Z4.

In an attempt to alleviate adverse effects of low wild stock levels, it has been suggested that fishers be involved in part-time mussel farming. One way to achieve this goal might be to grow mussels on spat collectors, thereby bypassing spat sleeving. This implies that population density on collectors may actually be different from optimal stocking density. Population density may be either too low to allow profitability or too high, with intraspecific competition being exacerbated. The bioeconomics of the project are under J.R. Wilson's supervision (Université du Québec à Rimouski). Here we present an account of population dynamics on mussel spat collectors focusing on self-thinning because it sets an upper limit to yield. Our study was done in Cascapedia Bay, Quebec, using two replicate collector lines which were sampled haphazardly on 14 occasions from October 2003 through October 2006. On each occasion, 30.5-cm lengths were taken from triplicate collectors sampled at two depths. In addition to biomass and population density, we monitored size structure, length-weight relationships of individual mussels, numbers of dead shells, multilayering of mussels, proportions of bare substrate, depths of the mussel lines and water temperature. Preliminary analysis indicated that biomass and population density were inversely correlated. Further analyses, which will include multilayering where necessary, should indicate whether this pattern may be evidence of self-thinning.

Using carbon and nitrogen isotopes as indicators of organic matter source in the diet of *Mytilus edulis* in integrated multi-trophic aquaculture systems.

T.R. Lander^{1,2 *}, S.M.C. Robinson¹, J.D Martin¹, T. Blair¹, K. Haya¹, L. Burrige¹, and F. Powell³

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²University of New Brunswick, Centre for Coastal Studies & Aquaculture, Centre for Environmental & Molecular Algal Research, P.O. Box 5050, Saint John, NB E2L 4L5, Canada

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The ability of *Mytilus edulis* to act as an appropriate biofilter of finfish wastes in an integrated multi-trophic aquaculture (IMTA) system depends on the suitability of farm organic output as a food source for the mussel, as well as the degree to which the allochthonous source is selected and ingested compared to autochthonous organic matter. Organic carbon and nitrogen discharged from salmon farms should have different isotopic compositions compared to those of marine autochthonous matter and the relative contributions of both sources to an organism's diet can be determined via an analysis of the isotopic composition of that organism. The isotopic signatures of carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) of mussels from IMTA and reference sites were investigated to trace changes in signatures of mussel tissues as a function of location relative to the output source. A lab experiment to trace the isotopic signatures of mussels fed three diets (ground salmon food, algae, and a 50/50 salmon food:algal mix) was also conducted to determine the degree of utilization of waste salmon food. Data will provide valuable insight into utilization of salmon farm wastes by *M. edulis* and the relative degree to which it is incorporated into its overall diet.



Ecosystem Health – Contributed Papers

Monday, November 20, 2006

10:20 AM - 12:30 PM

Location: Harbour Suite B

Chair: Rich Moccia (University of Guelph)

10:20 R.D. Moccia

Chemical and physical properties of trout feces: implications for benthic loading and modeling of deposition zones for freshwater aquaculture.

10:40 G.K. Reid

Integrated multi-trophic aquaculture (IMTA) in the Bay of Fundy, Canada: Modelling salmonid nutrient loading as the initial step towards the development of an overall IMTA model.

11:00 F.H. Page

Initial experiences with the use of the DEPOMOD model in relation to salmon farming in the southwest New Brunswick area of the Bay of Fundy.

11:20 F. Salazar-Hermoso

Evaluating stable isotopes for the identification and quantification of aquaculture solids in the natural environment.

11:40 T. Francis

Revitalising our environmental resources for sustainable aquaculture.

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



Chemical and physical properties of trout feces: implications for benthic loading and modeling of deposition zones for freshwater aquaculture.

Moccia^{1*}, R.D., D.J. Bevan¹, G.K. Reid² and H. Zhou³

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Settleable solids of fecal waste from cultured fish represent the largest contributor of organic material to the benthos adjacent to a cage aquaculture facility. The composition of various feed ingredients, and their level of incorporation into fish diets, can influence both the chemical and physical properties of feces from fish fed these diets. The chemical composition of feces from rainbow trout fed 3 commercial trout diets was determined by broad-spectrum analysis of fecal solids produced in lab feeding trials. For the macro-nutrients, total nitrogen ranged from 3.1 to 5.2 %, phosphorus ranged from 2.2 to 3.9 %, and potassium was less than 0.3 % (dry weight basis) of the solid waste produced. Micro nutrient levels were, copper 20-77 mg/kg, iron 700-1300 mg/kg and zinc 437 – 890 mg/kg. Other metals concentrations ranged widely, with most being below detection limits. Fecal settling velocity varied between the 3 diets, ranging from less than 0.1 to more than 7 cm/second, with median settling velocities ranging between 4.3 and 6.1 cm/second. These velocities are higher than most other data on salmonid feces, which has implications for the modelling of deposition zones, and estimation of benthic impacts from nutrient and metal contributions to the freshwater ecosystem.

Integrated multi-trophic aquaculture (IMTA) in the Bay of Fundy, Canada: Modelling salmonid nutrient loading as the initial step towards the development of an overall IMTA model.

G.K. Reid^{1,2*}, S.M.C. Robinson², T. Chopin¹, T. Lander^{1,2}, M. Sawhney¹, B. MacDonald¹, K. Haya², L. Burridge², F. Page², N. Ridler¹, S. Boyne-Travis³, J. Sewuster⁴, M. Szemerda⁵, F. Powell⁵ and R. Marvin⁵

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⁵Cooke Aquaculture Inc., 14 Magaguadavic Drive, St. George, NB E5C 3H8, Canada

The first step in the development of an overall flexible model for an IMTA system is the estimation of nutrient loading from the finfish component and, consequently, what nutrient inputs are available to lower trophic co-cultured species. A 'mass balance' approach using bioenergetics to quantify and predict growth has long been a staple in fish nutrition, and was used to develop a first iteration of a Salmonid loading component with Simile modeling software. A thermal growth coefficient is used to predict the energy demand required for fish growth under a given temperature regimen. The feed energy required to achieve this growth is used to develop a feeding standard and therefore what nutrients will enter the system. Percent digestibility of protein (*i.e.* nitrogen), lipids, carbohydrates, minerals and phosphorus determines the quantity and composition of fecal waste, and what is potentially available to organic extractive species. Digested minus retained nutrients determines the soluble waste component and potential availability for inorganic extractive species. Future model development, present knowledge gaps and implications for IMTA management are discussed.



Initial experiences with the use of the DEPOMOD model in relation to salmon farming in the southwest New Brunswick area of the Bay of Fundy.

Page, F.H.*¹, Losier, R.L.¹, McCurdy, E.P.¹, Chang, B.D.¹, MacKeigan, K.¹, Warrington, S.¹, Szemerda, M.²

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

²Cooke Aquaculture Inc., St. George, NB E5C 3H8

This ACRDP project focuses on gaining experience with the application of the DEPOMOD particle tracking and deposition model to salmon farming in the southwestern New Brunswick area of the Bay of Fundy. The project is a joint project with Cooke Aquaculture and it is mid way through its three year time scale. Current meter data has been gathered from several moorings at each of several farm sites, sediment sulphide concentrations have been determined from grab surveys of sites and time series of GPS data from the corners of sites. The DEPOMOD model has also been run for different scenarios at sites. The presentation will give an update on these activities.

Evaluating the use of stable isotopes for the identification and quantification of aquaculture solids in the natural environment.

F. Salazar-Hermoso*¹, D.P. Bureau² and R.D. Moccia¹

¹Aquaculture Centre, Department of Animal and Poultry Science, University of Guelph, Ontario, Canada N1G 2W1

²Fish Nutrition Research Laboratory, Department of Animal and Poultry Science, University of Guelph, Ontario, Canada N1G 2W1

Growth of the freshwater cage-aquaculture industry is constrained by the need to better manage, and sometimes mitigate, the environmental impacts resulting from nutrient waste production. One promising method to help identify the origins of settleable solid wastes from fish farms, utilizes the analysis of stable isotope signatures. An isotope 'signature' is determined by quantifying the ratios of stable isotopes of Nitrogen and Carbon found in different organic materials. Isotopic signatures of various common feed ingredients had $\delta^{13}\text{C}$ values from -12.92 to -25.85‰, and $\delta^{15}\text{N}$ from 0.47 to 12.43‰. When these ingredients were combined in different proportions, the corresponding whole diets had $\delta^{13}\text{C}$ values between -19.55 and -20.78‰, and $\delta^{15}\text{N}$ values between 5.27-9.34‰. There was also a distinct signature in the fecal material of cultured rainbow trout fed these diets that corresponded to the diet's formulation. Related signatures were also detected in the carcass musculature of these fish. Field trials were then conducted at a commercial fish farm to determine if benthic deposits in the near-field regions around the site could be identified as farm origin. Finally, our results are compared with other published data on isotope signatures of various flora and fauna commonly found in the Great Lakes watershed.

**Revitalising our environmental resources for sustainable aquaculture.**

Tazoacha Francis

Action Centre for Rural Community Development, P.O. Box 368, Buea, South West Province, Cameroon Tel: +237 5903841, acercd98@yahoo.com

The actual fishing activities have the greatest bearing on the environment, as the long-term availability of the resources depends on the extent to which these activities are geared to the resource situation and to the conditions prevailing in the ecosystem fished. Through centuries of experience, traditional artisanal small scale fisheries based in a specific location have made sure that they do not over fish the available resources. Any attempt to increase production can jeopardize this well-established equilibrium utilized at the level below that guaranteeing optimum yield and sustainability. It may nevertheless be possible to increase production without endangering the resources. Such an opportunity exists in cases where the stocks fished are utilized at a level below that guaranteeing optimum yield and sustainability. The same applies if fishing activities are extended to those components of the biocoenoses within the ecosystem that were previously utilized very little or not at all. Apart from the need to conserve the resources themselves, it is also essential to protect their environment against influences that could raise problems in short or long term. To this end, the physical, chemical and biological condition of fishing areas must be monitored. Product quality depends on the chemical and biological condition of the water and on the sanitary conditions prevailing ashore (village hygiene). The destructive effects of using wood resources for smoking fish can be curbed in two ways: by employing energy saving kilns which permit more rational use of wood and ensuring appropriate management of the forest resources concerned. The amount of wood required for boat building can be reduced by replacing dugout canoes with boats made of planks and by using alternative construction materials. Where it is likely that infrastructure for landing places used in artisanal fishery can be modified or removed only with difficulty, such facilities should not be constructed unless their necessity and expediency have been thoroughly reviewed. Concrete structures can also mar the aesthetic value of their surroundings (tourism). Harvesting the products entails a lot of environmental hazards when unorthodox means are employed such as using chemicals. This does not only destroy the ecosystem but also the indiscriminate and wanton destruction of the species in question. Consequently stock management calls for a high level of training in fishery biology and adequate knowledge of fishery economics. Stock regulating measures should be discussed, agreed upon and implemented by the local fishermen acting on a collective basis.



Invasive Species – Tools and Support for Managing the Impact of AIS on Aquaculture

Monday, November 20, 2006

1:40 PM - 4:20 PM

Location: Commonwealth A Ballroom

Chair: Thomas Landry (Fisheries and Oceans Canada)

- 1:40 Thomas Landry**
Introduction to AIS Terminology
- 2:00 TBA**
Monitoring: Review of the monitoring efforts and results from Atlantic, Central and Pacific Zones
- 2:20 TBA**
Control: Strategies, tools and legislation to manage the spread and introduction of AIS.
- 2:40 TBA**
Research: Research programs (i.e. CAISN) and contributed presentations
- 3:00 TBA**
Research: Research programs (i.e. CAISN) and contributed presentations
- 3:20 TBA**
Treatment and mitigation: Recent advancement on treatment and mitigation
-



Shellfish Culture – Contributed Papers (Continued)

Monday, November 20, 2006

1:40 PM - 4:40 PM

Location: Harbour Suite A

Chair: TBD

- 1:40 B. Myrand**
Grow-out of soft-shell clams, *Mya arenaria*, before seeding.
- 2:00 B. Myrand**
Development of open-sea culture of mussels in Iles-de-la-Madeleine (Québec): four years later.
- 2:20 J. Power**
Growth, feeding and motile behaviour in the blue mussels (*Mytilus* sp.) in the presence of the starfish, *Asterias vulgaris*.
- 2:40 I. Redjah**
Physiological response of juvenile American oysters, *Crassostrea virginica*, to thermal changes.
- 3:00 A. Trottet**
Modelling the carrying capacity of semi-enclosed lagoons for shellfish farms.
- 3:20 M. Liutkus**
Development of a submersible longline system for blue mussel (*Mytilus edulis*) culture.
- 3:40 K. Karimzadeh**
An investigation of dietary calcium on survival, moulting and body composition of juvenile crayfish (8-9g), *Astacus leptodactylus*.
- 4:00 M. Mamoser**
Shellfish aquaculture industry response to site assessment needs and ecosystem-based management approach.

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



Grow-out of soft-shell clams, *Mya arenaria*, before seeding.

Lise Chevarie¹, Bruno Myrand^{2*}, and Réjean Tremblay³

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²Centre maricole des Iles-de-la-Madeleine, MAPAQ, 107-125 chemin du Parc, Cap-aux-Meules, QC G4T 1B3

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Young soft-shell clams obtained through either benthic or pelagic collection reach an average of ~7-9 mm (range of 2.5-15 mm) in fall in Iles-de-la-Madeleine. At this time, it is too late in the season for seeding. Thus, the clams are wintered under the ice cover in suspended structures like pearl-nets, oyster bags, ... Growth is minimal during this period. In early summer, the young clams are still smaller than the recommended size for successful seeding (SL > 15 mm). They must get through a grow-out phase before being seeded. Different grow-out strategies (FLUPSY, floating oyster bags and sand-filled trays) have been looked at for clams growth and survival since 2005. Logistics were also examined for the different strategies and their operation costs roughly estimated. Two seeding strategies are possible according to the clams growth rate during the grow-out phase : (1) seeding in late July/early August if clams can double their mean size in about 2 mo (growth of ~ 1 mm / wk) or (2) wait a whole year (until next summer) before seeding if growth is slower. Preliminary results will be presented and discussed.

Development of open-sea culture of mussels in Iles-de-la-Madeleine (Québec): four years later.

François Bourque and Bruno Myrand*

Centre maricole des Iles-de-la-Madeleine, MAPAQ, 107-125 chemin du Parc, Cap-aux-Meules, QC G4T 1B3

Mussel culture is concentrated in sheltered lagoons in Iles-de-la-Madeleine but there is no room for new leases. In 2002, we began to look at the potential for culture in open waters. An experimental site was chosen 7 km away from the harbour of Cap-aux-Meules at a depth of 19 m. This site is usually free of ice during winter except for occasional ice drifting. Three longlines were deployed at 10 m from the surface. None have moved from its anchors after 4 years. In 2005, a continuous sleeve (400-m long) was suspended to one longline. Over the years, spat collection success was examined as well as growth, production and meat yield. Mussels can reach the commercial size as fast as in the lagoons, i.e. 12 mo after sleeving. Commercial yields of 6.7 kg / m were obtained in November. During summer, meat yield is higher for mussels in open sea than in the lagoons. This is partly due to their thinner shells : ~ 50% lighter for a similar size. Preliminary observations suggest these shells are robust enough to go through processing with no additional shell breakage. Commercial culture in open waters will possibly begin in 2007.



Growth, feeding and motile behaviour in the blue mussels (*Mytilus sp.*) in the presence of the starfish, *Asterias vulgaris*.

J. Power* and C. Couturier

School of Fisheries, Marine Institute of Memorial University, St. John's, NL, A1C 5R3. Email: joanne414@yahoo.com

Predation of mussels, *Mytilus sp.*, by the common starfish *Asterias vulgaris* can be a serious problem on mussel farms around the globe. In addition to direct predatory losses, starfish can affect growth and behaviour in wild mussels, so it is important to understand these possible influences on farmed mussels. The objectives of this study were to determine the relationship between the presence of starfish waterborne chemical cues ('scent') and the growth, feeding rate, and mobility of the blue mussels at both low and high temperatures. Our findings show that mussels exposed to starfish 'scent' grew slower, had a reduced clearance rate for food and showed reduced mobility over those not exposed to starfish chemical cues. Visual observations suggest mussels produced more byssal threads when exposed to higher concentrations of starfish scent. Temperature influenced the relationship between starfish scents and mussel performance but the pattern was unclear. We conclude that high standing biomass of starfish below or near culture gear can contribute to reduced mussel performance, and hence losses to farmers. The implications at the farm level will be discussed.

Physiological response of juvenile american oysters, *Crassostrea virginica*, to thermal changes.

Redjah, Iften*¹, Tremblay, Réjean^{1,2} and Pernet, Fabrice³

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In St. Lawrence Gulf, the American oyster, *Crassostrea virginica*, lives in salted waters with high temperature variations between the winter (~ 0°C) and the summer (~ 20°C). As the summer growing season related to high temperature is short, New-Brunswick oyster producers need fast growing individuals. The first part of this study was to compare the physiological (scope for growth) and biochemical (lipid class) parameters in relation to thermal changes of different oyster families, pool (mix of families) and natural spat produced in the Shippagan's (N.B.) Aquarium and Marine Center hatchery. Physiological and biochemical parameters have been compared after 3 months transfer in commercial growing site, at three temperatures: 20°C (optimum conditions), 12°C (field condition at sampling) and 4°C (wintering preparation condition). The scope for growth showed significant differences between hatchery spat and with natural spat. These differences were related to metabolic demand and filtration capacity. Finally, relation between physiological parameters and lipid class analysis will be presented in relation with hatchery and natural spat performance.



Modelling the carrying capacity of semi-enclosed lagoons for shellfish farms: impact of mussel filtration on the plankton in Magdalen Islands (Québec, Canada)

A. Trottet ^{*1}, E. Tamigneaux², S. Roy¹, C. Lovejoy³ and R. Tremblay¹

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Blue mussels have been cultivated in Magdalen Islands' lagoons for over 25 years and the local mussel industry would like to increase production and develop new culture sites. However, sustainable production in such semi-enclosed ecosystems depends on the interactions between shellfish farms and the environment. A research programme was set up in 2003 to determine the carrying capacity of the Grande Entrée Lagoon (GEL) for suspended mussel culture. Physical modelling has shown that, in this shallow marine environment, there is mixing and slow renewal of the waters (~20-25 days) by local winds. The present study specifically examined the influence of filtration activity by cultured mussels on microplankton communities. Low nutrient concentrations in summer together with the dominance of small-size phytoplankton and high biomass of heterotrophic protists suggest that the pelagic ecosystem is mainly microbial food web driven. In support of this, we found that heterotrophic protists contribute the greatest planktonic biomass retained by mussel filtration. Using extensive field data gathered in 2003 and 2004 and ecosystem modelling, we compare the structure of the planktonic food web inside and outside of the mussel farm and explore its changes between spring and summer.

Development of a submersible longline system for blue mussel (*Mytilus edulis*) culture

M. Liutkus^{*}, C. Couturier and J. Cross

School of Fisheries, Marine Institute of Memorial University, St. John's, NL, A1C 5R3. Email: mliutkus@hotmail.com

There is an ongoing need in the mussel aquaculture industry for developing innovative technologies to remain competitive and to keep production increasing. A submersible longline system for deeper, nearshore or open waters could provide a number of benefits, including reduced costs of production, optimizing growth by targeting 'food layers' within the water column, and avoidance of settlement of fouling organisms. Trials were undertaken to evaluate air lift technology as a method of varying the depth of a culture backline. An innovative lift device was developed for such practices and tested in flume tanks. The physical parameters associated with buoyancy of a longline system using mussels in various physiological conditions and stocking rates were determined and modelled. A model longline system was tested in a large flume tank to simulate submerged conditions and assess the performance of the mooring system, drops, and backline under varying current speeds. The overall performance of the system and recommendations for future developments will be discussed.



An investigation of dietary calcium on survival, moulting and body composition of juvenile crayfish (8-9g), *Astacus leptodactylus*.

Katayoon Karimzadeh* and Asgar Zahmatkesh

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Mirza Koochak Khan Higher Education Center for Fishery Science and Technology, P.O. Box: 41635-3836, Rasht, Iran.

The objective of this study was to evaluate the effect of dietary calcium on survival, moulting and body composition of (8-9 g) freshwater crayfish, *Astacus leptodactylus*. Triplicate groups of crayfish (mean initial weight of 8.18 g) were fed semi purified, casein-gelatin based diets containing five levels of Ca (0, 1, 2, 3, 4%) from $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ for 80 days. At the end of experiment, survival and body composition of crayfish significantly affected by different dietary treatments but moulting abundant not affected. The survival of the crayfish was enhanced when calcium was added to diets. At high levels of calcium supplementation, poor lipid and ash but high protein contents in whole body of crayfish was estimated. The body calcium of crayfish fed 1 and 2 % calcium diets tended to be higher than crayfish fed other experimental diets. Phosphorus contents in the whole body were greater in crayfish fed diets containing of 1-2 % calcium. Based on these data, it seems that existing of calcium in diets progress survival and moulting performance of crayfish. Also values of 1-2 % dietary calcium is needed for optimum tissue mineralization.

Shellfish aquaculture industry response to site assessment needs and ecosystem-based management approach.

M. Mamoser*¹, R. Canessa¹, J. Grant², P. Cranford³ and M. Archambault²

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³Oceans and Environment Branch, DFO, Bedford Institute of Oceanography, Dartmouth, NS B2Y 4A2

The shellfish aquaculture industry presents a viable means of economic diversification in coastal communities hardest hit by the closure of traditional resource-based industries. The industry is already established on both the East and West coasts of Canada with the potential for further expansion, but the availability of suitable grow-out sites has become one of the biggest challenges facing both industry proponents and regulators. Site selection is paramount in ensuring the sustainable development of the industry from both a social, economic and environmental perspective. Fisheries and Oceans Canada (DFO) has a policy of ecosystem-based management of the shellfish aquaculture industry. The use of remote sensing, geographic information system (GIS) and the associated spatial analysis is one way of meeting this policy objective by departing from the current case-by-case model used for site selection and management of the industry to an approach in which synoptic information for a broader region such as a bay, inlet, sound or other marine region is assessed. An important component of ecosystem-based management is its emphasis on collaboration across all user groups. The effectiveness of spatial technology to achieve an ecosystem-based approach must take into account the needs of the regulators and the industry proponents. A questionnaire assessing industry proponent needs for site selection and achieving ecosystem-based management was sent out to all shellfish farmers in British Columbia and Nova Scotia. This presentation will focus on the preliminary results stemming from these questionnaires.



Aquaculture Development, Policy and Regulation – Contributed Papers

Monday, November 20, 2006

1:40 PM - 3:20 PM

Location: Harbour Suite B

Chair: TBD

1:40 J. Fraser

Traceability – a necessary evil or a business opportunity?

2:00 N. Ridler

Prospective analysis of aquaculture development; the Delphi method.

2:20 J. Grant

Management of aquaculture site selection via regional habitat classification: bridging science and policy.

2:40 N. Ridler

Enhancing sustainability of salmon culture in Canada: a socio-economic analysis of integrated multi-trophic aquaculture (IMTA).

3:00 R. Jayaraman

Small-scale aquaculture for livelihood development of tsunami-hit fisherfolk in India through microfinance.

Traceability - a necessary evil or a business opportunity?

Jennifer Fraser*¹, Keith Richford ²

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Recent regulatory developments on both sides of the Atlantic (EU Traceability Legislation, the Bioterrorism Act, and COOL Legislation) have spurred the need for Aquaculturists to carefully consider implementing or enhancing their current traceability systems. In an industry as complex and diverse as aquaculture, with not only the names of species and harvesting methods varying across international boundaries, but also widely varying rules surrounding vaccines, veterinary medicines, and feed additives for farm-raised fish, the cost of meeting these regulations can seem a steep one. However, it is important to also understand the economic benefits that can be derived from such systems. Traceability systems can reduce labour and other production costs, increase food safety and quality control, provide credibility to back up marketing claims (such as organic salmon, for example), and reduce costly and damaging environmental adverse publicity that has so dogged the aquaculture industry. Implemented properly, traceability systems can enhance customer confidence and provide a marketplace advantage. A firm understanding all of the facts surrounding traceability is essential to every organization engaged in the production and marketing of farmed seafood products.



Prospective analysis of aquaculture development; the Delphi method.

F. Butin¹, N Hishamunda¹ and Neil Ridler^{2*},

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Recognizing the increasing contribution of aquaculture to livelihoods and economies worldwide, as well as the potential challenges to further development of the sector, the FAO of the UN undertook a prospective analysis, the objectives of which were to: (1) qualitatively forecast the future of regional and global aquaculture development; (2) determine and analyse important policies which could affect aquaculture development regionally and globally and; (3) determine priority areas for action in aquaculture (regionally and globally). It was decided to adopt the “Delphi method” because of its advantages; amongst which: anonymity – thus avoiding the limitations of group decision-making, e.g., over-dominant group members, deference to seniors; expert inputs; iteration with controlled feedback. Initially 305 questionnaires were sent out via mail to experts in different regions. Six regions were identified: Africa, Asia/Pacific, Latin America, North America, East Europe and Western Europe. This paper presents some of the Delphi results, with an analysis of their policy implications in different regions in the world. Particular attention is paid to results from North America.

Management of aquaculture site selection via regional habitat classification: bridging science and policy.

Jon Grant^{1*}, Marie-Claude Archambault¹, Michael Sutherland¹, Peter Cranford², Rosaline Canessa³ and Melanie Mamoser³

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Large bays or estuaries with areas for potential aquaculture development exist in Nova Scotia. The licensing and monitoring process is arduous for aquaculture proponents, as well as federal and provincial regulators with little accrual toward a global system view. The process is lengthy and the cost to regulators in person-hours is severe, with significant financial cost to the applicant. While procedural improvements can make the existing process more effective, it lacks information that feeds into ecosystem views of coastal management. Geographic information systems (GIS) have played an increasing role in aquaculture management, e.g. in Nova Scotia and British Columbia. Geostatistical modelling has been scarce in aquaculture planning despite its ability to define boundaries, habitats, and undertake constraint mapping to exclude unsuitable areas. We undertook field studies and spatial analysis of site assessment parameters at 3 shellfish culture sites in Nova Scotia. Comparison of approaches at local level (spot sampling) were compared to a synoptic view based on acoustic surveys of sediment type and/or grid sampling. The results are discussed in terms of the quality of information provided by each approach relative to the goals of habitat managers to protect environmental integrity. This research permits regional habitat mapping to be assessed as an approach to more efficient and effective aquaculture licensing and monitoring.



Enhancing sustainability of salmon culture in Canada: a socio-economic analysis of integrated multi-trophic aquaculture (IMTA).

N Ridler^{1*}, M. Wowchuk, K. Barrington¹, T. Chopin¹, S. Robinson², F. Page², K. Haya², A. Justason, R. Marvin, F. Powell and J. Sewuster

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There is concern about the long-run sustainability of salmon aquaculture in Canada. On the west coast there is mistrust and generally negative attitudes towards the industry, and on both coasts concern about environmental impacts. There is also a question whether salmon farming is economically viable if prices fall. One strategy to enhance sustainability is to complement salmon cultivation with the cultivation of additional species at the same site. Not only might profitability be increased and risks reduced but social perceptions improved. In addition remediation of organic and inorganic waste from salmon may occur. This paper examines the sustainability of a multi-trophic operation in eastern Canada where salmon are grown with mussels and seaweeds. The paper presents a bio-economic model, which suggests that profitability, when compared with salmon monoculture, increases because additional costs are more than offset by additional revenues. Risks are reduced. In addition, focus groups indicate that integrated multi-trophic aquaculture is well-perceived by the general public and stakeholders, which should lessen mistrust towards the industry.

Small-scale aquaculture for livelihood development of tsunami-hit fisherfolk in India through microfinance

R. Jayaraman*

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Rehabilitation of Tsunami-hit fisherfolk through appropriate livelihood development is the current development priority in India. Several employment and income generating options have been provided to the affected fisherfolk in six coastal districts in Tamilnadu, the worst-affected in the country. Adoption of the various livelihood development options is essential for the sustainability of the fisherfolk welfare. Neither the government nor the fisherfolk could survive on freebies alone in the long run. This paper presents results of a case study which showed that small-scale aquaculture plays a pivotal role in rebuilding the life of Tsunami-hit fisherfolk through microfinance. The strategy lies in imparting necessary techno-economic skills to the fisherwomen who have grouped themselves into a Self Help Group (SHG) and providing microfinance through banks and other required support through NGOs. It paves way for not only in rebuilding the lives of many fisherfolk in Tsunami-hit coastal villages but also to empower them and to attain the benefits of Millennium Development Goals (MDG).



Current Topics in Aquaculture – Contributed Papers

Monday, November 20, 2006

2:00 PM - 3:30 PM

Location: Harbour Suite B

Chair: TBD

3:20 J. Conroy

Performance characteristics of the horizontal moving-bed biofilter.

3:40 M. Couturier

Velocity profiles in multi-drain circular tanks.

4:00 M. Ramachandram

Land-based aquaculture solids management using bio-treatment technology.

4:20 R. Mehrennezhad

Culture and purification of *Dunaliella salina* of Urmia Lake.

4:40 R. Mehrennezhad

Evaluation of hatching percentage and hatching efficiency of *Artemia urmiana* cysts.

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

Performance characteristics of the horizontal moving-bed biofilter.

Jessica Conroy^{*1}, Michel Couturier¹, Zhijie Ma¹, Ying Zheng¹, and Adrian Desbarats²

¹Recirculating Aquaculture Research Group, Department of Chemical Engineering, University of New Brunswick, P.O. Box 4400, Fredericton, NB, E3B 5A3, Canada

²Atlantech Companies, 89 Hillstrom Avenue, Charlottetown, PEI, C1E 8C3, Canada

The hydrodynamic, nitrification, degassing and oxygenation characteristics of the horizontal moving-bed biofilter were investigated in this study. The biofilter consists of a rectangular box opened to the atmosphere; a baffle located at the midpoint divides the unit into two tanks in series. Water is fed at one end of the biofilter and overflows at the opposite end. The biofilter is filled with buoyant plastic beads which act as the support media for the nitrifying biofilm. Rising air bubbles generated by the injection of air at the base of the biofilter stir the beads. Residence-time-distribution tests and spatial ammonia concentration measurements confirmed that each half of the biofilter is hydrodynamically well mixed. The rate of nitrification is first order with respect to the ammonia concentration, and the nitrification rate constant based on biofilter volume is 0.003s^{-1} . The air bubbles keep the water saturated in oxygen and provide significant removal of carbon dioxide. The overall mass transfer coefficient for oxygen and carbon dioxide transfer was measured in a lab-scale moving bed and found to be about 0.2 min^{-1} . By combining nitrification, degassing and oxygenation in one low-head unit, the horizontal moving-bed biofilter eliminates the need for a degassing column and offers new design opportunities for reducing the pumping costs of recirculating aquaculture farms.



Velocity profiles in multi-drain circular tanks.

Benoît Despres and Michel Couturier*

Recirculating Aquaculture Research Group, Department of Chemical Engineering, University of New Brunswick, P.O. Box 4400, Fredericton, NB E3B 5A3, CANADA

Circular fish-rearing tanks can be designed as self-cleaning primary solids separators. The rotational velocity in circular tanks generates a secondary radial flow along the floor that carries settled particles to the central drain. The shape of the tangential velocity profile determines the strength of the secondary flow and therefore whether the tank is self-cleaning. The objectives of this project were to study the hydrodynamic characteristics of multi-drain tanks and to develop a model for predicting the tangential velocity profile within the tanks. Work was done on 1.5m and 5m double-drain and triple-drain tanks. It was found that the most important variables affecting the tangential velocity profile are the radial position, the type and the angle of the inlet pipe, the total flow rate and the fraction of the incoming flow leaving via the central drains. In agreement with model predictions, the tangential velocities near the center of the tank increase as the inward radial bulk flow increases. It is also shown that the triple-drain tank design provides greater flexibility than the conventional double-drain designs for controlling tank hydrodynamics.

Land-based aquaculture solids management using bio-treatment technology.

M. Ramachandran^{*1}, K. S. Singh^{1,2}, B. G. Wilson², M. F. Couturier¹

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²Department of Civil Engineering, University of New Brunswick, Fredericton, N.B., Canada E3B 5A3

A respirometric technique was used to assess the feasibility of the application of anaerobic digestion technology and/or aerobic composting process to aquaculture biosolids. A batch study on digestibility of aquaculture biosolids was conducted at two different F/M ratios. Based on batch results a digester with an active volume of 4L was started and operated at room temperature (23°C±2). Performance of the digester was studied during start up and continuous operation. The digester was fed continuously with VS loading of 0.6 kg/m³.d, loading rates were gradually increased until any inhibition was not noticed. To evaluate the biodegradation of aquaculture biosolids using a composting process, a respirometer study was conducted. Aquaculture solids were blended with paper sludge to maintain various moisture contents and C/N ratios. Different blends of paper sludge and aquaculture solids resulted in C/N ratios that ranged between 19:1 and 58:1 respectively. In the same manner, digested solids were added to the paper sludge to obtain a C/N ratio of 26:1 to 71:1. In both the cases paper sludge alone, with a C/N ratio of 109:1, was taken as a control. Compost samples were considered to attain stability when oxygen uptake stopped. This study suggests that a complete waste management system for aquaculture solids could be achieved using anaerobic digestion technology followed by aerobic composting process.



Culture and purification of *Dunaliella salina* of Urmia Lake.

Reza Mehrannezhad

Young researchers club, urmia Islamic azad university, Urmia, Iran. Email:rmehrannezhad@yahoo.com

There are different products such as B-carotene, Agar and est. extract from Phytoplanktons. *Dunaliella salina* is one of the families of green algae considered as and unicellular and flagellate algae. *Dunaliella* is considered as an effective nutrient in all research systems of productive and other systems. *D. salina* is a natural inhabitant of Urmia Lake, and it is the main food of *Artemia urmiana*. In this survey first the samples are taken from lake then after filtration by special alcohols are cultured under standard condition in Vallne media at 24°C. After growth of algae and increasing of its density, samples are investigated under microscope and then algae are purified by micropipettes under invert microscope. Afterward the pure samples are moved to solid media so the isolated samples can growth and then moved to liquid media.

Evaluation of hatching percentage and hatching efficiency of *Artemia urmiana* cysts.

Nemat Peykaran¹ and Reza Mehrannezhad^{2*}

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Today, various life stages of *Artemia* such as newly hatched nauplius is the only food for postlarvae stage in shrimps. Nauplius maybe applied for feeding the larval stage of sturgeon, ornamental and marine fishes. The main life stage of shrimp in which *Artemia* cysts are mostly used is postlarval stage (from mysis to pL₁₅). Hatching efficiency and percentage are two important factors for assessment of the cysts consumption rate in shrimp farms and also in cysts price determination. Salinity, temperature, pH, oxygen and light are the most effective factors in hatching efficiency and percentage. Hatching percentage is defined as the number of nauplii which are produced from 100 cysts under the standard incubation. Hatching efficiency is the number of the nauplii which are produced from one gram dried cysts under the standard incubation.



Aquaculture Canada^{OM} 2006

Plenary I

Tuesday, November 21, 2006

8:30 AM – 9:30 AM

Location: Commonwealth A Ballroom

8:30 J. Sackton

Challenges to Marketing Aquaculture Products

Honourary Lifetime Achievement Award

Tuesday, November 21, 2006

9:30 AM – 10:00 AM

Location: Commonwealth A Ballroom

9:30 L. Poirier

Aquaculture, the situation in Quebec



Industry Marketing and Communications

Tuesday, November 21, 2006

10:20 AM - 12:30 PM

Location: Commonwealth A Ballroom

Chair: Jason Mullen (Aquaculture Association of Nova Scotia)

10:20 G. Butte

Building consumer confidence: consumer perceptions of farmed salmon"

10:50 R. Swartz

Benefits versus risks of seafood – where do we stand?

11:20 J. Sackton

Market reaction to customer perceptions of aquaculture products

11:50 M.E. Walling

Farmed salmon: how an ENGO coalition frames the salmon farming in B.C

Building consumer confidence: consumer perceptions of farmed salmon

G. Butte

This presentation will discuss the “Strategic Risk Communications Approach Selected to Address Farmed Salmon Consumption in Canada” project. Fisheries and Oceans Canada, (DFO), was faced with growing skepticism in Canada about salmon farming practices and the risks of farmed safety to human health. DFO decided to take a strategic approach to communicating with Canadians on farmed salmon consumption and Decision Partners was commissioned to conduct mental models research to provide DFO with the insight into Canadians' decision-making on fish consumption -particularly farmed salmon consumption. We began early last year by working with DFO and other regulatory and industry experts to integrate knowledge about consumers' salmon purchase decisions into an "expert model." We then used the model to design and analyze in-depth interviews with 60 consumers in three Canadian communities. Some of the research findings will now impact the development of strategic communications within both government and industry. The research revealed that interviewees generally knew that salmon is a healthy food choice: a good source of Omega-3, high in protein, and low in calories, with particular benefits for human heart and brain functions. They were also generally aware of the controversy that exists about salmon aquaculture practices. They felt that the benefits of eating farmed salmon outweighed the risks, including the risks highlighted in recent controversies. On the other hand, many interviewees were not aware that salmon, wild or farmed, is a safe food, or that it is low in saturated fat. They did not know that salmon aquaculture is responding to a growing global demand for fresh, nutritious and affordable fish and seafood, nor that the use of antibiotics and food additives in Canadian aquaculture is strictly regulated. For example, Canadians clearly were interested in knowing what the (unbiased) experts have to say about salmon, and they want to know the truth about the farmed salmon "problems" that have been in the news. They also want detailed information on management practices in salmon aquaculture and how safe and/or healthy salmon is -both farmed and wild. DFO's use of a strategic risk communications process will help guide strategy and communications development and help ensure Canadians are equipped with the information they consider important for decision-making on farmed salmon purchase and consumption.



Benefits versus risks of seafood – where do we stand?

Rosie Swartz

Scientific studies about the benefits of consuming seafood - fish, shellfish and other offerings from the sea - continue to be published at a regular pace. Yet, some people are wary about putting these foods on the menu due to reports of various contaminants in some fish. But the scientific consensus is that the benefits of seafood consumption far outweigh the risks. This presentation will provide insight into the risks as well as health benefits of consuming seafood right through the life cycle. Seafood's nutritional contributions play a role from brain and neurological development in a fetus and maintenance of cognitive function in the elderly to the treatment of inflammatory diseases like rheumatoid arthritis and heart disease and stroke.

Market reaction to customer perceptions of aquaculture products

John Sackton

President, Seafood.com

What can producers do to overcome negative customer perceptions of certain aquaculture products? What attributes make aquaculture products attractive to consumers? We will review the major Canadian aquaculture species.

Farmed salmon: How an ENGO coalition frames the salmon farming issue in British Columbia

Mary Ellen Walling*^{1,2}

¹Royal Roads University

²BC Salmon Farmers Association #302 871 Island Highway, Campbell River BC V9W 2C2

This paper describes and interprets how an environmental non-profit coalition develops and frames their communications strategies in the midst of an ongoing social controversy on salmon aquaculture in the context of the modern globalized environmental movement. Focusing on the Coastal Alliance for Aquaculture Reform's (CAAR) Farmed and Dangerous campaign against salmon farming in British Columbia, this paper describes how framing processes are used as a tool to further CAAR's political and organizational goals using technology and the media to make claims. This paper takes existing literature on framing approaches in social movements and explores how CAAR members frame the issue in order to preserve messaging alignment within their coalition and the use of technology to implement communicative strategies. Techniques such as persuasive opposition and the use of celebrity are described to show how ENGOs frame their communications using enduring cultural themes to influence government, retailers, consumers and ultimately public policy.



Atlantic Cod Culture – Contributed Papers

Tuesday, November 21, 2006

10:20 AM - 12:30 PM

Location: Harbour Suite A

Chair: Chris Hendry (NL Department of Fisheries and Aquaculture)

10:20 L. Lush

An egg by any other name....a comparison of gamete collection methods for Atlantic cod (*Gadus morhua*) broodstock.

10:40 A. Kellett

Influence of lighting regime on the sexual maturation of cage cultured Atlantic cod (*Gadus morhua*).

11:00 S.M. Tibbetts

Utilization of plant protein sources by juvenile Atlantic cod (*Gadus morhua* L.).

11:20 E.A. Trippel

Use of continuous light and triploidy to control sexual maturation in farmed Atlantic cod (*Gadus morhua*).

11:40 M. Clarke

Lipids and fatty acids as indicators of egg and larval viability in Atlantic cod (*Gadus morhua*).

12:00 A. Garber

Initial performance evaluation of cultured Atlantic cod (*Gadus morhua*) families.

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



An egg by any other name....a comparison of gamete collection methods for Atlantic cod (*Gadus morhua*) broodstock.

L. Lush^{*1}, D. Drover², A. Walsh², V. Puvanendran³, J. Symonds⁴

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Communal spawning tanks allow for minimal stress and handling of broodstock. Atlantic cod (*Gadus morhua*) readily spawn in captivity, producing large volumes of high quality eggs, without practitioner intervention. However, with communal spawning no selection of individual pairs is attempted, leaving the possibility that certain animals can out-compete others for mates and in gamete production. Communal mating may limit the selection of those individuals which could pass on the best traits for aquaculture to the offspring, possibly limiting the production potential of the species for industry. Family-based selective breeding has led to advances in growth for salmon and catfish, and is currently being investigated in Atlantic cod (www.codgene.ca), with the aim to improve production through improved growth, survival, disease and environmental tolerance, and final marketable quality. The collection of high quality gametes is a crucial starting point for a successful breeding program. A comparison between three methods of gamete collection was performed, investigating differences between egg quality and survival in communal, paired mated and stripped spawned Atlantic cod broodstock. Results show variation in fertilization rate and other egg parameters between the groups investigated.

Influence of lighting regime on the sexual maturation of cage cultured Atlantic cod (*Gadus morhua*).

A. Kellett¹, V. Puvanendran¹, A.A.H. Mansour² and C.Couturier³

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The early maturation of cage cultured Atlantic cod (*Gadus morhua* L.) is a concern in the development of viable aquaculture. Photoperiod manipulation has been shown to have significant effects on delaying maturation in cod reared in tanks, however the results in sea cages are not clear. We are investigating the effects of continuous light on early maturation of Atlantic cod in sea cages on the southcoast of Newfoundland. Two experimental groups of 2000 cod, each in two cages, were exposed to continuous light (24 hrs a day) from two 900 lux submerged bulbs. Control fish in two other cages received only the natural photoperiod. This experiment was started at the summer solstice when the cod juveniles were only 15 months old. Samples of 15-30 fish were taken 5 times between June 2005 and May 2006. Experimental fish exposed to continuous illumination had lower gonadosomatic and higher hepatosomatic indices which could be an indication of a difference in their level of maturity. Histological investigation of ovaries further revealed a greater number of vitellogenic oocytes in the experimental group. Growth was not different between the experimental and the control groups. A swimbladder abnormality found predominantly in experimental fish may explain similar growth rates in both groups. Our results indicate that supplying continuous light could be effective in delaying early maturation in Atlantic cod in sea cages.



Utilization of plant protein sources by juvenile Atlantic cod (*Gadus morhua* L.).

Sean M. Tibbetts* and Santosh P. Lall

National Research Council of Canada, Institute for Marine Biosciences, 1411 Oxford Street, Halifax, Nova Scotia, Canada, B3H 3Z1

Protein and their constituent amino acids are essential components of marine fish diets. Although, high-quality fishmeal is the major source of protein in fish feeds, the increasing demands of global aquaculture upon this finite resource necessitates that feeds become increasingly comprised of alternative protein sources of plant and/or animal origin. Canada is a major producer and importer of plant proteins including oilseed, pulses and cereal grains. Plant proteins may contain anti-nutritional factors or toxicants that may adversely affect digestion, absorption and physiological utilization of nutrients. The ability to tolerate maximum amounts of various plant proteins may vary among fish species. Incorporation of highly digestible plant proteins in cod diets must support similar performance to fishmeal, make economic sense and, concurrently, have little effects upon fish health and the environment.

In this study, we determined the apparent digestibility coefficients (ADCs) for protein and energy of 10 plant-based protein sources by juvenile Atlantic cod (~90 g). Protein ADCs were high (86-100%) for wheat gluten meal, soy protein concentrate, soy protein isolate, soybean meal, pea protein concentrate, white lupin meal, canola protein concentrate and corn gluten meal; mid-range (76%) for canola meal; and low for flaxseed meal (50-55%). Energy ADC was high (88-95%) for wheat gluten meal, soy protein concentrate, soy protein isolate and soybean meal; mid-range (75-83%) for canola protein concentrate, corn gluten meal, pea protein concentrate and white lupin meal; and low (21-61%) for canola meal and flaxseed meal. These coefficients will have practical application in formulation of commercial cod diets.

Use of continuous light and triploidy to control sexual maturation in farmed Atlantic cod (*Gadus morhua*)

E.A. Trippel^{*1}, T.J. Benfey², S.R.E. Neil¹, M.J. Blanchard¹, S.E. Corrigan¹, and F. Powell³

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As wild finfish stocks decline throughout many of the world's oceans, interest in the culturing of selected species is increasing. In many marine species, the juveniles selected for grow out attain sexual maturity well before harvest size. Onset of puberty is commonly associated with reduced somatic growth, enlarged gonads and livers, and seasonal variation in fillet quality. In this presentation, we provide a preliminary report on the feasibility of controlling onset of sexual maturation using two methods: continuous light (24 h) and induction of sterility through triploidy. Atlantic cod (*Gadus morhua*) stocked to sea cages were maintained either under continuous light or natural ambient photoperiod. Seasonal samples of fish from sea cages revealed that 24 h light levels significantly delayed onset of sexual maturity by several months. The effectiveness of photoperiod manipulation may be related to both light intensity and seasonal timing of initiation of light. Cod triploids, perhaps the first-ever generated worldwide, were produced using pressure shock. Sibling diploids and triploids were PIT tagged, reared collectively and a group stocked in sea cages and another maintained in tanks. Fish will be examined throughout the upcoming spawning period to examine for seasonal effects of sterility on somatic and gonadal growth. Future investigations using both these techniques are required to address the maturation problem; as cod farmers consider early puberty to be a major obstacle to commercialization.



Lipids and fatty acids as indicators of egg and larval viability in Atlantic cod (*Gadus morhua*).

M. Clarke^{1*}, C.C. Parrish¹, and R. Penney².

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An understanding of the factors affecting egg and larval quality can serve as a means to separate poor eggs from high-success eggs, thus allowing producers to select viable eggs that will result in maximum rates of fertilization, hatch, and larval survival. Biochemical composition is examined as an indicator of egg and larval viability in cod, correlating fertilization rates, hatch rates and survival with profiles of lipids, and fatty acids. Batches of eggs spawned from cultured cod broodstock at the OSC facilities were used, with fertilization rates ranging from 45% - 99%, and hatching success ranging from 4.5% to 96%. Samples were taken at six stages from spawn to yolk-sac absorption (10 dph). Lipid analysis was carried out using an Iatroscan Mark V TLC/FID analyzer. The fatty acid composition of the sample was analyzed by Hewlett-Packard gas chromatograph with a flame ionization detector. Results for these samples are currently being sorted according to fertilized vs. unfertilized eggs, hatching success, and survival to see if there are statistical relationships between lipid and fatty acid profiles and egg viability, looking both at each individual stage and at the changes over time. Statistical analysis will be done using ANOVA and multiple comparison tests. Funding by Department of Fisheries and Oceans.

Initial performance evaluation of cultured Atlantic cod (*Gadus morhua*) families

A. Garber^{*1,4}, V. Puvanendran², A. Robinson³, S. Neil⁴, E. Trippel⁴, S. Walker¹, D. Boyce², K. Gamperl², L. Lush⁵, G. Nardi⁶, F. Powell⁷, A. Walsh⁸ and J. Symonds¹

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The decline in wild cod populations has resulted in fisheries closures throughout Atlantic Canada. Cod aquaculture is widely recognized as one way to supply cod to the marketplace while providing stability to the established salmon aquaculture industry through species diversification. Broodstock selection is an important aspect of developing a new candidate species for culture. To this end, the Atlantic cod genomics and broodstock development project (CGP, www.codgene.ca), managed by Genome Atlantic, was initiated to create two regional family-based selective breeding programs in New Brunswick/New Hampshire (NB/NH) and Newfoundland & Labrador (NL). The CGP has produced 107 full and half sibling families for communal rearing in sea cages. Family data have been collected on juvenile cod ranging from 159-237 days post hatch on 49 families from the NB/NH program ($n \sim 12,500$ progeny) and 26 families from the NL program ($n \sim 5,250$ progeny). Preliminary data analysis has revealed significant variation between families in growth (weight, length), condition factor, and the incidence and types of deformities. Heritability estimates associated with these traits are being calculated and will be presented. Preliminary data analysis is encouraging as it demonstrates the possibility for improvement of important commercial production traits in the developing cod aquaculture industry.



Finfish Health – Contributed Papers

Tuesday, November 21, 2006

10:20 AM - 12:30 PM

Location: Harbour Suite B

Chair: Russell Easy (NRC-IMB/Dalhousie University)

10:20 V. Puvanendran

Possible causes of vertebral deformity in Atlantic cod larvae.

10:40 L.D. Bruce

Effect of temperature stress on clinical infections of nodavirus in Atlantic cod (*Gadus morhua*).

11:00 B.R. Chavan

Impact of heavy metals on fresh water fish *Cirrhinus mrigala* in relation to oxygen consumption.

11:20 B.D. Chang

Phytoplankton early warning approaches for salmon farms in southwestern New Brunswick.

11:40 J.L. Martin

Industry enumeration, early warning and hind-casting of harmful phytoplankton blooms in southwest New Brunswick

12:00 L.E. Burridge

Lethality of microalgae to farmed Atlantic salmon.

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

Possible causes of vertebral deformity in Atlantic cod larvae.

V. Puvanendran^{1*} and Colleen Calder-Crewe²

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Skeletal deformities have become a major concern in several cultured marine finfish species. Environmental stress during embryonic stages could have a negative impact in skeletal formation which could result in skeletal deformities. To test this hypothesis, Atlantic cod eggs were incubated at four different densities, 3, 6, 12 and 48 ml eggs per L of water. Water quality parameters such as oxygen, ammonia, carbon dioxide and temperature were monitored throughout the incubation period. Once hatched, larvae were transferred to 30L glass aquarium and reared using standard larval rearing protocols. Samples were taken at various intervals from hatching to 56 dph. To document skeletal deformities, we used bone and cartilage staining methods. Incubation density did not have a significant effect on skeletal abnormalities in Atlantic cod larvae. However, our results indicate that husbandry, genetics and/or nutrition could play a major role in vertebral deformities of Atlantic larval cod.



Effect of temperature stress on clinical infections of nodavirus in Atlantic cod (*Gadus morhua*).

Lisa D. Bruce^{1,2*}, Stewart C. Johnson¹, Sandra A. Sperker¹, Laura L. Brown¹.

¹National Research Council of Canada, Institute for Marine Biosciences, Halifax, NS, Canada

²Department of Biology, Dalhousie University, Halifax, NS, Canada.

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Losses due to nodavirus (NNV) disease are one of the main impediments to the successful culturing of many marine fish species. The virus can cause 100% mortality in larvae; however, empirical evidence suggests that NNV is carried within the juveniles and adults without obvious clinical signs. The goal of this study is to examine the role of elevated temperature in NNV disease in Atlantic cod. Two hundred cod (20-30g), from a population suspected to be carriers of NNV, were evenly stocked in 10 tanks. Five tanks were held at ambient seawater (4-6°C) and five at 17°C. Fish in 4 tanks at each temperature (160 fish) were injected i.p. with 10^8 TCID₅₀ ml⁻¹ NNV. One tank at each temperature (40 fish) was injected with culture medium only. Fish were monitored for disease and samples for RT-PCR were obtained over a 21-day period. Although high proportions (>60%) of both the control and challenged groups tested positive for NNV there were no signs of disease in either group held at ambient temperature. Thirty-nine percent of the challenged fish held at 17°C showed signs of disease. Our results show that cod can be carriers of NNV and that elevated temperature can cause overt disease.

Impact of heavy metals on fresh water fish *Cirrhinus mrigala* in relation to oxygen consumption.

B.R. Chavan^{*1}, M.P. Bhilave², D.V. Muley², Amararatne Yakupitiyage¹

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²Dept. of Zoology, Shivaji University, Kolhapur - 416 004, INDIA.

Industrialization affects the environmental pollution of air, soil and water with both Organics and inorganic. Metal affects the metabolism of aquatic organisms. The latter can accumulate both essential (Fe, Zn, Cu, Mn) and non essential (Hg, Pb, Cd) metal present in water (Kumar, 2001). However these non-degradable persistent trace metals are the most pressing problems of the present day. Some important physiochemical factors which influence toxicity and uptake of metals by organisms include temperature, Oxygen content, water hardness, and concentration of organic compound, pH and salinity. The effects of cadmium and lead in relation to oxygen consumption in freshwater fish *Cirrhinus mrigala* (*C. mrigala*) have been investigate. The fish were exposed to predetermined LC₀ (0.098 and 19.352 ppm) and LC₅₀ (0.132 and 21.849 ppm) concentrations of cadmium chloride and lead acetate respectively for 96 hrs. Both the heavy metals showed increased rate of oxygen consumption when compared to control. The fluctuated response in respiration may be attributed to inhibition in mitochondrial oxidation and energy metabolism due to the heavy metal stress.



Phytoplankton early warning approaches for salmon farms in southwestern New Brunswick: project summary.

Chang, B.D.*¹, Martin, J.L.¹, Page, F.H.¹, Harrison, G.², Horne, E.², Burrridge, L.E.¹, LeGresley, M.M.¹, Hanke, A.R.¹, Losier, R.¹, and McCurdy, E.P.¹

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²Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, NS B2Y 4A2

This ACRDP project investigated the feasibility and cost-effectiveness of several potential early warning approaches for predicting harmful phytoplankton blooms at salmon farms. The components of this project included: training of farm personnel on the identification of harmful phytoplankton species; implementation of daily phytoplankton monitoring by farm staff at selected salmon farms in southwestern New Brunswick; retrospective analyses of existing phytoplankton monitoring data; laboratory experiments to determine threshold concentrations of selected harmful phytoplankton species which cause problems for farmed salmon; water circulation studies to determine the spatial and temporal origin of water (which could transport phytoplankton blooms) entering salmon farms; evaluation of the effectiveness of a light sensor array for bloom detection; and evaluation of the usefulness of satellite imagery for bloom detection. The proposed field and laboratory programs were completed in 2004 and 2005, with the collaboration of 4 salmon farms in each year. Data analysis and report preparation are mostly completed and the project will end in March 2007. This presentation will provide an overall summary of the project's activities and results. Other presentations at this conference will provide additional information on the enhanced monitoring and threshold concentrations components of this project.

Industry enumeration, early warning and hind-casting of harmful phytoplankton blooms in southwest New Brunswick

J.L. Martin*, M.M. LeGresley, B.D. Chang and F.H. Page

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

Within the past decade, harmful phytoplankton blooms have compromised the health of fish at a number of salmon farms in southwest New Brunswick. An ACRDP project was undertaken in 2004 to look at a monitoring approach that would provide an early warning of an upcoming potentially harmful event. The objectives were to determine the feasibility and need for high frequency sampling and the design of a cost effective operational approach for phytoplankton monitoring. Individuals from salmon industry partners were trained in collection, identification and enumeration of potentially harmful phytoplankton species that might cause problems with the salmon. Samples collected for phytoplankton from 4 sites during 2004-05 were analysed by trained personnel at salmon farms and a comparison with results from analyses by staff at the Biological Station will be presented as well as analyses for spatial and temporal characteristics of existing phytoplankton monitoring data. In 2004, a number of salmon farms were affected when *Alexandrium fundyense*, the organism responsible for producing paralytic shellfish poisonings, bloomed at densities exceeding 3 million cells•L⁻¹. The ability of the industry to analyse additional samples provided an opportunity to mitigate some of the bloom effects and reduce the number of mortalities.



Lethality of microalgae to farmed Atlantic salmon.

L.E. Burrige*, J.L. Martin, M.C. Lyons, M.M. LeGresley and B.D. Chang.

Fisheries and Oceans Canada, St. Andrews Biological Station, 531 Brandy Cove Road, St. Andrews New Brunswick, E5B 2L9

Phytoplankton in the Bay of Fundy have been implicated in the deaths of farmed Atlantic salmon. To establish whether elevated concentrations of algae can cause mortality, monocultures of microalgae, *Alexandrium fundyense*, *Ditylum brightwellii* and *Chaetoceros socialis* were grown in mass cultures. Atlantic salmon smolts were exposed to a range of concentrations of these cultures for 24 hr and an LC50 was determined according to the concentration of cells present (cells•L⁻¹). Cultures of *D. brightwellii* at concentrations as high as 106 cells•L⁻¹ had no deleterious effect on the salmon. This concentration is well above the concentrations observed in the wild. While behavioural responses were noted in salmon exposed to 4X10⁶ chains•L⁻¹ of *C. socialis*, only one fish died during the experiments. Some concentrations of *A. fundyense* were lethal to salmon. The LC50 was estimated to be 614,000 cells•L⁻¹, a concentration that has been observed in the wild. Samples of the cultures used in our exposures were analysed for PSP toxins by HPLC. These data together with information on the size of fish used in the experiments were used to calculate an LD50 for *A. fundyense* and salmon of 1.8 mg (PSP equivalents)•Kg⁻¹ (fish).



R&D Tax Credit Program

Wednesday, November 22, 2006

2:00 PM – 3:20 PM

Location: Commonwealth A Ballroom

Chair: Lynette Carey (Newfoundland Aquaculture Industry Association)

2:00 D.J. Arsenault

SR&ED tax program: fostering scientific and technological innovation in Canada

2:20 G. Whey

Are you getting the R&D tax credit you deserve? SR&ED best practices in aquaculture

2:40 TBA

Perception and use of the SR&ED tax incentive from industry



Challenges to Marine Aquaculture II – Aquaculture in Cold Oceans

Tuesday, November 21, 2006

3:20 AM - 4:30 PM

Location: Commonwealth A Ballroom

Chair: K. Vanya Ewart (National Research Council)

3:20 G.L. Fletcher

Fish antifreeze proteins: Their potential value to sea cage aquaculture in cold waters.

3:40 C. Audet

Finfish aquaculture management and biological adaptations to cold water.

4:00 S. Doiron

Overwintering methods of long line systems for shellfish.

Fish antifreeze proteins: Their potential value to sea cage aquaculture in cold waters

Garth L. Fletcher^{*1}, Neal R. Pettigrew², Rod S. Hobbs¹ and Peter L. Davies³

¹Ocean Sciences Centre, Memorial University, St John's NL

²Department of Oceanography, University of Maine, Orono ME

³Department of Biochemistry, Queen's University, Kingston ON

Superchill is a term used by the aquaculture industry to account for fish mortalities that occur when temperatures decline below the freezing point of their blood plasma. The freezing temperature of plasma is determined by the concentrations of electrolytes and antifreeze proteins (AFP). Fish lacking AFP (salmon, charr, halibut) have a limited degree of freeze protection (~ -0.7°C) whereas fish possessing AFP (winter flounder, ocean pout) can survive temperatures as low as -1.8°C. Since superchill conditions occur along the Atlantic coast of Canada and Maine, there is a clear need to devise methods to reduce the potential for freezing mortalities. One approach is to improve the freeze resistance of the cultured species by AFP gene transfer. Our studies using antifreeze genes from winter flounder and ocean pout have established the "proof of concept" that such genes can be stably integrated into the genome of Atlantic salmon and expressed. The challenge is to design more efficacious AFP gene constructs. Our first approach was to take advantage of the powerful antifreeze proteins found in insects. However recently we discovered a fish antifreeze that is just as effective. Since fish genes are likely more acceptable to the consumer, we believe that research into producing transgenics with these genes is a worthwhile endeavour. Research supported by NSERC and CIHR.



Aquaculture management and biological adaptations to cold water.

C. Audet

Institut des sciences de la mer de Rimouski, Université du Québec à Rimouski, Rimouski (Qué.) G5L 3A1

Cold-water aquaculture not only requires technological adjustments, but it must also deal with or take advantage of biological adaptations that are present in species, populations or local stocks. Our knowledge of cold-water species is often too restricted to even identify traits of interest. When such traits are known, the development of new molecular biology tools combined with quantitative genetics can help to select breeders and develop aquaculture stocks that will have these traits of interest for cold-water production. A few examples drawn from studies done in Atlantic Canada, with special emphasis on winter flounder research studies, illustrate how a better understanding of biological adaptations to cold water could be useful for developing or improving aquaculture. For many years, winter flounder was used as a model for the study of the production and properties of antifreeze proteins. Using a south–north gradient, we developed a research program that aims to answer different questions: How do larval and juvenile development in cold water compare among breeders of different origins? Is antifreeze production related to environmental conditions, or does it differ among populations? Does feeding behaviour in cold-water conditions differ according to the production level of anti-freeze proteins? In addition, we examine the utility of sperm banks for developing strains for cold-water aquaculture.

Overwintering methods of longline systems for shellfish culture.

Doiron, Sylvio*

Department of Agriculture and Aquaculture of New Brunswick, 100 De l'Aquarium Street, Shippagan, N.B., E8S 1H9

In New Brunswick, aquaculture has significant economic value. There is interest in the rearing of two species of shellfish on the province's east coast: the blue mussel (*Mytilus edulis*) and the eastern oyster (*Crassostrea virginica*, Gmelin). Although the rearing techniques are well known, overwintering still poses a considerable challenge. There are two major steps in mussel rearing: spat collection and growout. Collection is done on the surface of the water, and growout is done on longlines suspended a few metres below the surface. That way, the socked mussels are not subject to the action of the waves and are protected from the thick layer of ice. The overwintering of the structures has been resolved, facilitating the harvest of the stock. Oysters are reared in floating structures on the surface of the water in most of the bays on N.B.'s east coast. The rearing sites are located in shallow waters (less than 3 metres deep). Two problems relating to the overwintering of the structures must be resolved: protection of the structures and winter harvest.



Finfish Culture – Contributed Papers

Tuesday, November 21, 2006

2:00 PM - 4:30 PM

Location: Harbour Suite A

Chairs: Caroline Graham (New Brunswick Salmon Growers' Association)

2:00 Y. Fessehaye

Application of microsatellite DNA markers for optimal design of Nile tilapia (*Oreochromis niloticus*) breeding program.

2:20 N. Pelletier

Life cycle measures of sustainability in salmon aquaculture.

2:40 R. O'Keefe

Temperature preference of diploid and triploid brook trout (*Salvelinus fontinalis*).

3:00 M.A. Chiasson

Hormonal sex reversal in Arctic charr (*Salvelinus alpinus*).

3:20 T.T. George

Early Rearing and Development of *Oreochromis niloticus*, in the Sudan.

3:40 S. Walker

Salmon breeding in Atlantic Canada – an update.

4:00 H. Abdollahpour Biria

Early development of the *Barbus capito*.

4:20 H. Abdollahpour Biria

Research on artificial spawning of *Barbus capito* and its larvae culture.

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



Application of microsatellite DNA markers for optimal design of Nile tilapia (*Oreochromis niloticus*) breeding program

Yonas Fessehaye^{1*}, Henk Bovenhuis¹, Mahmoud A. Rezk², Richard Crooijmans¹, Hans Komen¹

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²The WorldFish Center, Regional office for Africa and W. Asia, Abbassa, Abou Hamad, Sharkia, Egypt

Mass selection schemes based on mass spawning can present low-cost selective breeding scheme for Nile tilapia. In mass spawnings, however, mating of the animals is not controlled and a small number of breeding individuals may account for a large proportion of the next generations leading to a higher inbreeding. To calculate reproductive and population parameters under mass spawning, we conducted mass spawnings with female to male sex ratio of 1:1, 2:1 and 3:1. About 10-20 larvae per incubating female were collected over spawning season. A multiplex of 7-11 polymorphic microsatellite markers were used to analyze parentage and estimate the reproductive success of individual males and females. Parentage analysis on 1880 offspring from 132 spawnings showed that only one third of males sired 70% (sex ratio 2:1) to 93% (sex ratio 3:1) of the offspring analyzed. The N_e/N was 0.4 (sex ratio 1:1) 0.45 (sex ratio 2:1) and 0.3 (sex ratio 3:1). The per-generation rates of inbreeding were 3.4% (sex ratio 1:1), 3.0% (sex ratio 2) and 4.37% (sex ratio 3). The implications of these results will be discussed in view of optimizing the designs of selective breeding schemes that will result in desired response without compromising the long term fitness of culture populations due to inbreeding.

Life Cycle Measures of Sustainability in Salmon Aquaculture

Nathan Pelletier*, Nathan Ayer, Peter Tyedmers

School for Resource and Environmental Studies, Dalhousie University, Kenneth C. Rowe Management Building, 6100 University Avenue, Suite 5010, Halifax, Nova Scotia, Canada, B3H 3J5

While discourse regarding the environmental repercussions of aquaculture is often dominated by proximate ecological concerns, a growing body of research indicates that the material/energetic demands of intensive production technologies can also precipitate considerable impacts. For net-cage salmon aquaculture, these secondary impacts stem largely from inputs to and emissions generated by the provision of concentrated feeds, the components of which derive from diverse agricultural and fisheries production systems. This research uses Life Cycle Assessment (LCA) methodology to compare the sustainability of conventional and organic salmon aquaculture feeds. By modeling a series of conventional and organic formulations based on existing and hypothetical standards, we assess the relative performance of these alternative scenarios with respect to a suite of biophysical criteria such as contributions to global warming, ozone depletion, acid precipitation, eutrophication, carbon appropriation, and ecotoxicity. As the “Blue Revolution” unfolds, our development choices must be informed by a coherent understanding of the biophysical implications of alternative production technologies. This analysis determines the environmental gains, if any, that may be achieved by a conversion to organic aquafeeds, and provides industry, policy makers, and NGOs with the information necessary to assess the value of facilitating organic aquaculture development in relation to specific environmental objectives.



Temperature preference of diploid and triploid brook trout (*Salvelinus fontinalis*)

Robyn O'Keefe* and Tillmann Benfey

Department of Biology, University of New Brunswick, Fredericton, N.B. E3B 6E1

Triploids are not used commercially because they do not appear to grow as well as diploids when cultured under identical conditions. However, in order for triploids to perform as well as diploids their optimal growth temperature must first be determined. Optimal growth is achieved when fish are cultured at their preferred temperature. The objective of this research is to determine the temperature preference of triploid fish, in order to determine whether it differs from that of diploids. Four replicate troughs (20 cm X 180 cm) were constructed, with water upwelling along the trough at four temperatures (12, 14, 16 and 18 °C) to provide a temperature gradient. Four trout (two of each ploidy, all 10 cm fork length) were placed in each trough and allowed free passage in order to choose their preferred temperature. Fish locations were recorded at random times between 9 AM and 5 PM during a four-day period. This was repeated eight times with a temperature gradient and with no gradient (control). The observed location frequency was used to determine the preferred temperature of the fish. This work is in progress and will be completed by the end of October. Once the optimal conditions, such as temperature, for the culture of triploids are determined, they may become more acceptable to the aquaculture industry. Funded by NSERC.

Hormonal sex reversal in arctic charr (*Salvelinus alpinus*)

Marcia A. Chiasson* and Tillmann J. Benfey

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When used to produce all-female populations, sex control reduces the incidence of early maturation and thus yields larger fish without the economic loss of reduced flesh quality. The aim of this research is to evaluate the suitability of the synthetic androgen 17 α -dihydromethyl testosterone (MDHT) for hormonal sex reversal in Arctic charr. Effective sex reversal is the first step in producing all-female stocks by indirect feminization. Immersion treatments with MDHT were evaluated using concentrations of 0.0 (control), 0.5, 1.0, 3.0, 5.0 and 10.0 mg/L (in triplicate) applied every 35°C-days for a total of 310°C-days, encompassing the interval from hatch to first-feeding. Fish were grown to 10 cm fork-length, at which time ten fish from each replicate were sampled lethally to prepare sections for microscopic analysis. The 10mg/L treatment was the most effective for sex reversal, resulting in 90% male fish. In a second experiment, feed samples containing MDHT at 0.0 (control) and 0.5 mg/kg (in triplicate) were fed to separate groups of fish for 600°C-days beginning at first feeding. The MDHT treatment group had 90% male fish. The results of this research will be of direct relevance to local fish farmers and will add to our basic knowledge of the developmental biology of fishes.



Egg enumeration, incubation, hatching and development of the “miracle fish”, *Oreochromis niloticus*, in the Sudan.

Afra A-A. Ahmed, Musab S. Abdalla and Prof. Thomas T. George*

School of Fisheries Sciences, Faculty of Agricultural Technology and Fisheries Sciences, Al Neelain University, Khartoum, Sudan.

The “Miracle Fish”, *Oreochromis niloticus*, is a mouth-brooder that exhibits a high degree of parental care. Brooding is strictly maternal and breeding females undergo physiological change before spawning begins – a ventral bulging of the hyoid region to increase the mouth capacity in order to accommodate the eggs after being fertilized by the male in a circular bowl-like nest built at the shallow part of the river bank or the pond. There are no records on the number of eggs accommodated in the female’s mouth nor the egg development after hatching until the fry stage. In this paper, therefore, egg enumeration, artificial incubation, hatching and development are recorded for the first time in The Sudan to promote sound hatchery operation and provision of quality fish seed.

Salmon breeding in Atlantic Canada – An Update.

S. Walker*¹, J. Jónasson², L. Vik² and J.A.K. Elliott³

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²Stofnfiskur hf, Stadarberg 2-4, 220 Hafnarfjörður, Iceland

³Cooke Aquaculture Inc., 874 Main Street, Black’s Harbor, New Brunswick, Canada, E5H 1E6

A family based selective breeding program for Atlantic salmon has been carried out in New Brunswick since 1984. In 2004 the stocks and activities of the Atlantic salmon broodstock development program were transferred from the centralized co-operative program to the participating industry partner sites. As the major industry partner Cooke Aquaculture Inc. continues to carry out fish performance evaluations and make selected family crosses utilizing PIT-tagged pedigreed broodstock groups held at biosecure land-based facilities. The Atlantic Canada Opportunity Agency’s Atlantic Innovation Fund provides funding for salaries and the microsatellite genotyping for family identification. Genetic evaluations using modern animal breeding techniques are carried out by researchers from Stofnfiskur. An overview of the current program will be presented.

Early development of the *Barbus capito*

Hamid Abdollahpour Biria *

Islamic Azad university of Bandar Anzalli , Bandar Anzalli, Guilan , Iran. E-mail: Abdollahpour51@yahoo.com

For the investigation of early development stage of barbus capito seventy five female broader and twenty female were caged in Sefideroud River. The fertilized eggs after hormonotraphy and fertilization held in zugg flask. The observations indicate that the early stage of growth of this species include nine embryonic stages, five larval stages and on Juvenile stage. The embryos stages begins with egg fertilization and ends with the change of hatched embryos to mixes food. Larval period of the development of the barbell reduction or loss of function of temporary embryonic organs (Yolk sac, embryonic respiratory organs, embryonic finfold). The larval period ends with the which occurs at 21 mm of total length of the larvae the characteristic traits of the Juvenile period include the development of the second pair of barbells and a nasal septum disappearance of the preanal part of the embryonic finfold and development of scales in the course of the period at the end of this stage TL= 36 mm and W= 980 mg.



Research on artificial spawning of *Barbus capito* and its larvae culture

Hamid Abdollahpour Biria *

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Barbus capito stock in Southern Caspian Sea are going to be vanishing . The aim of artificial spawning investigation are to restore the stock and enhance its capture fishery with considering its conservation . For eggs stripping , 75 numbers of females species of *Barbus* with mean weight of 4.7 kg and 20 male ones with average weight of 1.75 kg captured in Sefidrood river's estuary area . The brooders through many stages in different ambient temperature (from April until the end of May in the year of 2005, water temperature range 17- 27°) being treated by carps pituitary gland (PG) for inducement , in the other tests it was also synthetic hormone such as LRH-a , LRH-a + HCG , PG + HCG , LRH-a + HCG +PG and PG + thyroxin , being used during experiments . As a results 5 females fish species achieved reproduction when the fish injected by the compounds of LRH-a + HCG + PG . The compound of PG plus HCG successfully induced a females brooder also the inducement occurred for another individual brooder when the fish were treated by PG + thyroxin hormones . Averagely , 4000 eggs with the diameter of 2-2.3 mm are extracted from each induced brooders after fertilization . The swelled eggs diameter measured 2.6-2.8 mm . The number of one gram dry weight of eggs was counted between 380-420 , which after fertilizing the number reduced to 120-140 in each gram weight . From total extracted eggs , after fertilization and incubation process at water temperature of 23° (2024 degree hours) nearly 12000 larvae with Yolk- sac (8.5-9.5 mm) are produced (Yolk- sac larvae of *B.capito* hatched in seventh phase of embryonic development) .The produced larvae absorbed their Yolk-sac after 4 days of hatching in 23° of water temperature . The larvae total - lenght measured 11.2-11.5 mm and weight 12 mg , it is also during this time period gas- bladder of larvae filled with air . The produced larvae fed with nauplii of *Artemia* including concentrated Starting Feed for Trout (SFT).The nursing practice to rear the larvae , took placed in small fiber- glass tank (2*2*1) and culturing lasted 15 days , then the *B.capito* fries introduced in an earthen pond (450 m²) for further growth.During culture period dissolved oxygen and PH of water measured on daily , and other data concerning physical and chemical factors of water collected weekly . Benthic animals biomass quantified by monthly. Finally , after 5 mounths culture process , survival rate were 60% , fingerling size measured 17 cm (TL), weight 50.1 gram were the output . Condition factor index during first month of rearing until fifth month were 1.02 , 1.85 , 1.4 , 1.17 , 2.26 respectively .



Finfish Health – Contributed Papers (Continued)

Tuesday, November 21, 2006

2:00 PM - 3:20 PM

Location: Harbour Suite B

Chairs: TBD

2:00 R.H. Easy

A case for mucus: an essential component in innate immunity in fish.

2:20 T.T. George

A short note on the survival on a deformed “miracle fish,” *Oreochromis niloticus* in an intensive water recirculating system

2:40 K. Azizpour

Probiotics and their role in disease resistance

3:00 T. Bagheri

Effects of probiotic supplement on growth, survival and gut microbial load of rainbow trout larvae, *Onchorhynchus mykiss* (Walbaum)

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

A case for mucus: an essential component in innate immunity in fish.

Russell H Easy^{1,2*} and Neil W Ross¹

¹Institute for Marine Biosciences—National Research Council, 1411 Oxford Street, Halifax, NS, Canada B3H 3Z1

²Department of Biology, Dalhousie University, 1411 Oxford Street, Halifax, NS, Canada B3H 2Z1

The epidermis of most teleost fish is covered with a layer of mucus containing proteins with various protective functions. Some of these proteins including acute phase proteins (APP) are responsible for many innate immune responses including inflammation, increased synthesis of hormones and an increase in leukocyte production. The innate immune system of teleosts includes a high degree of evolutionarily conserved elements and a possible source of biomarkers useful for inferring exposure to pathogens and identifying conditions in the environment that have a negative effect on the organism. Following infection by the sea louse (*Lepeophtheirus salmonis*) there is a marked increase in lysozyme and alkaline phosphatase (AP) concentrations in the mucus. Transferrin, an iron binding protein and APP, has also been identified in the mucus of stressed fish using molecular and biochemical assays. Such constitutive and inductive processes have several roles including preventing the adherence of pathogenic organisms to its host. Our study is aimed at defining which proteins are present in mucus and under which conditions the levels of these proteins change. We will further characterize these proteins and their responses to other stressors including long and short-term handling stress.



A short note on the survival on a deformed “miracle fish”, *Oreochromis niloticus* in an intensive water recirculating system

Thomas T. George*

Professor, School Of Fisheries Sciences, Faculty of Agricultural Technology and Fisheries Sciences, Al Neelain University, Khartoum, Sudan ; Aquaculture Consultant, Toronto, Canada

The “Miracle Fish”, *Oreochromis niloticus* is a world’s most important fresh/marine, warm water cultured food fish, farmed from extensive to super intensive water recirculating systems. This is because it is very hardy and tolerates varying degrees of physical and chemical characteristics of the water media. Besides, it was found that it can survive even when it is deformed. This paper reports on how an *Oreochromis niloticus* could develop the dorsal and ventral fins to perform the action of an atrophied caudal fin.

Probiotics and their role in disease resistance

Kh.Azizpour*

Artemia and Aquatic Animals Research Institute, Urmia University, Urmia-Iran. P. O. Box, 53157-165, St. Bahashti

The probiotics were defined as live microbial feed supplements that improve health of man and terrestrial livestock. The gastrointestinal microbiota of fish and shellfish are peculiarly dependent on the external environment, due to the water flow passing through the digestive tract. Most bacterial cells are transient in the gut, with continuous intrusion of microbes coming from water and food. This extension of the probiotic concept is pertinent when the administered microbes survive in the gastrointestinal tract. Otherwise, more general terms are suggested, like biocontrol when the treatment is antagonistic to pathogens, or bioremediation when water quality is improved. Most attempts to propose probiotics have been undertaken by isolating and selecting strains from aquatic environment. These microbes were Vibrionaceae, pseudomonads, lactic acid bacteria, *Bacillus* spp. and yeasts. Three main characteristics have been searched in microbes as candidates to improve the health of their host. (1) The antagonism to pathogens was shown in vitro in most cases. (2) The colonization potential of some candidate probionts was also studied. (3) Challenge tests confirmed that some strains could increase the resistance to disease of their host. Many other beneficial effects may be expected from probiotics, e.g., competition with pathogens for nutrients or for adhesion sites, and stimulation of the immune system. The most promising prospects are sketched out, but considerable efforts of research will be necessary to develop the applications to aquaculture.



Effects of probiotic supplement on growth, survival and gut microbial load of rainbow trout larvae, *Onchorhynchus mykiss* (Walbaum)

T. Bagheri^{*1}, V. Yavari¹, M. Alizade², A. Farzanfar² and H. Pasha¹

1. Fisheries department, Marine Science university, Khoramshahr, Iran, P.O. Box 669

2. Cold water fishes research center, Tonekabon, Iran

Larvae rearing in rainbow trout farming is of great importance. This phase is critical and simply affected by several stress under farming conditions. In this case, subclinical infections often result in reduced growth and increased mortality. Many studies have shown that probiotics can improve the growth rate and survival of fishes, so a 63-day feeding experiment was conducted. Experimental diets supplemented with probiotic at five levels, ($T_1:4.8 \times 10^8$, $T_2:1.2 \times 10^9$, $T_3:2.01 \times 10^9$, $T_4:3.8 \times 10^9$, $T_5:6.1 \times 10^9$), one control group served as well. FCR, NPU, PER, and survival in the probiotic groups were significantly higher ($P \leq 0.05$) than control group (except T_1). CF, only in T_4 was significantly higher than control group. SGR in T_4 and T_5 , and WGP in T_3 , T_4 and T_5 were higher compared to those with the control ($P \leq 0.05$). T_5 recorded a maximum growth and survival among treatments. Our findings support the effectiveness of probiotic supplementation on growth and survival of rainbow trout larvae. At the end of experiment, sample for microbial load analyses were taken from intestine. Enterobacteriaceae, Vibrionaceae, Pseudomonaceae, some gram negative bacteria and Bacillus were identified. Bacillus, contrast to control group, was dominated in intestine of probiotic groups. This suggested that the probiotics colonized in the gut of the fishes and suppressed the growth of other microbes.



Environmental Management

Tuesday, November 21, 2006

3:20 PM - 4:45 PM

Location: Harbour Suite B

Chairs: Jon Grant (Dalhousie University)

3:20 J. Grant

Introduction

3:25 G. Reid

Freshwater finfish cage culture environmental management

3:45 A. McGarry

Marine finfish cage culture environmental management

4:05 P.J. Cranford

Indicators and thresholds for use in assessing shellfish aquaculture impacts on fish habitat:
Science recommendations to DFO national advisory process

4:25 TBA

Linking animal health and environmental health – Activities of the new AquaNet node



Indicators and thresholds for use in assessing shellfish aquaculture impacts on fish habitat: Science recommendations to DFO national advisory process

Peter J. Cranford^{*1}, Robin Anderson², Philippe Archambault³, Toby Balch⁴, Stephen S. Bates⁵, Gary Bugden¹, Myriam D. Callier³, Claire Carver⁶, Luc Comeau⁵, Barry Hargrave¹, W. Glen Harrison¹, Ed Horne¹, Paul E. Kepkay¹, William K.W. Li¹, André Mallet⁶, Marc Ouellette⁵, and Peter Strain¹

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³ Institute Maurice-Lamontagne, 850 Route de la Mer, Mont-Joli QC G5H 3Z4

⁵ Gulf Fisheries Centre, 343 Ave Université Ave, Moncton, NB E1C 9B6

⁴ Nova Scotia Fisheries and Aquaculture, 5151 George St., Halifax, N.S., B3J 3C4

⁶ Mallet Research Services, 4 Columbo Dr. Dartmouth, NS B2X 3H3

A national DFO workshop was conducted in 2006 to meet DFO Habitat Management's needs for science advice related to the fish habitat effects of shellfish aquaculture in the marine environment. One goal of the workshop was the provision of science advice on appropriate methodologies for assessing these effects in a nationally coherent decision-making approach. Our specific objectives were: (1) to identify, evaluate and make recommendations regarding a range of quantitative indicators (measures of habitat and ecosystem status) that could be used to monitor for potential shellfish aquaculture effects; and (2) to provide science-based decision support for the development of an environmental monitoring framework, based on identification of predetermined impact limits (operational thresholds) intended to trigger management actions. All recommendations were made to promote the avoidance and mitigation of any harmful alteration, disruption and destruction (HADD) of fish habitat. A wide range of ecosystem and habitat status indicators and methodological approaches were identified and each was screened based on habitat impact predictions and observations. Selected indicators were classified based on associated strengths and weaknesses using predefined criteria, including: availability of operational thresholds; regulatory needs; cultured species; scales of impact addressed; cost/benefit; and the needs of responsive management. A pragmatic habitat assessment framework is recommended for the highly diverse Canadian shellfish aquaculture industry that addresses the need for a consistent and transparent decision-making approach that is science-based, and reflects both fish habitat and ecosystem concerns.



Plenary II

Wednesday, November 22, 2006

8:30 – 9:30 AM

Location: Commonwealth A Ballroom

8:30 A. Alvial

Culturing Quality and Confidence: The Chilean Salmon Cluster Experience

Research Award of Excellence

Wednesday, November 22, 2006

9:30 – 10:00 AM

Location: Commonwealth A Ballroom

9:30 D. Higgs



Genomics in Aquaculture

Wednesday, November 22, 2006

10:20 AM - 12:30 PM

Location: Commonwealth A Ballroom

Chair: Jane Symonds (Huntsman Marine Science Centre)

10:20 M. Dennis

Aquaculture genomics: building a globally-competitive Canadian aquaculture industry

10:40 S. Bowman

Cod genomics in Atlantic Canada

11:00 M. Rise

Salmonid EST database and DNA microarrays: tools for functional genomics research

11:20 L. Brown

From sequence to sickness: genomic approaches to aquatic disease management

11:40 M. Reith

Pleurogene: Genomics for the production of Atlantic halibut and Senegal sole

Cod genomics in Atlantic Canada

S. Bowman^{*1}, B.Higgins¹, C.Stone¹, C.Kozera¹, B.A.Curtis¹, J.Tarrant Bussey¹, H.Verheul¹ and S.C.Johnson²

¹The Atlantic Genome Centre, Halifax, Canada;

²National Research Council Institute for Marine Biosciences, Halifax, Canada;

Atlantic cod is poorly represented in current sequence databanks. A major aim of the Atlantic Cod Genomics and Broodstock Development Project (CGP: www.codgene.ca) is to generate an extensive set of molecular tools for cod, including a large expressed sequence tag (EST) component. To date, approximately 25,000 EST sequences have been processed from a set of normalised cDNA libraries. These libraries were produced from various tissues (brain, heart, ovary, gill) sampled from fish collected in New Brunswick and Newfoundland. Individuals collected at the same time as sampled fish have been used to generate cod families for selective breeding. Sequence generated is currently being mined for marker development. Three different methods of generating markers within specific genes have been assessed. These include identification of gene-linked microsatellites, development of exon-primed intron-flanking (EPIC) markers and analysis of single nucleotide polymorphisms (SNPs) within EST clusters. Ultimately, a set of markers will be used to generate a high resolution genetic map for Atlantic cod, and markers will also be used for analysis of quantitative trait loci (QTL) in the CGP cod family programs. Sets of genes will also be selected for inclusion on a "cod chip" microarray. Current progress towards these goals will be presented.



Salmonid EST databases and DNA microarrays: tools for functional genomics research

M.L. Rise^{*1}, K.R. von Schalburg², G.A. Cooper², G.D. Brown², W.S. Davidson³, and B.F. Koop²

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³Department of Molecular Biology and Biochemistry, Simon Fraser University, Burnaby, BC V5A 1S6

Expressed sequence tag (EST) databases and DNA microarrays are fundamental tools in genomics research. Approximately 500,000 salmonid ESTs have been submitted to NCBI's EST database, and about half of these come from each of two species: Atlantic salmon (*Salmo salar*) and rainbow trout (*Oncorhynchus mykiss*). Primary contributors of salmonid ESTs to public databases include the Genome Canada-funded consortium for Genomic Research on All Salmon Project (cGRASP), a Norwegian Salmon Genome Project, and USDA and INRA rainbow trout projects. Large-scale salmonid genomics projects focused on characterizing high-complexity cDNA libraries (normalized, subtracted) to accelerate gene discovery. cGRASP has sequenced over 270,000 Atlantic salmon clones (yielding over 350,000 high-quality sequences) from cDNA libraries representing various tissues and life stages, and has generated smaller EST collections from other salmonid species. Applications of the cGRASP EST database include mining (i.e. to detect morphogenic activities in mature gonads), and selection of genes to be included on the ~16,000-gene (16K) cGRASP cDNA microarray. cGRASP microarrays are popular tools for salmonid global gene expression profiling, and have been used for research related to aquaculture, disease, conservation, and toxicogenomics. Genomic research will likely aid in the development of methods (i.e. identifying disease resistant broodstock) that will benefit salmonid aquaculture.

From sequence to sickness: using genomics and biotechnology to understand aquatic animal pathogens

L.L. Brown^{*1}, E. Altman², J. Boyd¹, A. Dacanay¹, R. Ebanks¹, K.V. Ewart¹, J. Li², D. Pinto¹, M. Reith¹, J.H.E. Nash², N. Ross¹, R. Singh¹, K. Soanes¹, J. Boyd¹, J. Walter¹, S.C. Johnson¹

We are studying the host-pathogen interactions between Atlantic salmon (*Salmo salar*) and *Aeromonas salmonicida*. We have sequenced the genome of the bacterium and this information has enabled us to investigate virulence factors and other gene products that may be vaccines or immunomodulatory candidates. Using knockout mutants of *A. salmonicida* and proteomics studies of bacterial cells grown in a variety of media as well as in an *in vivo* implant system; we have revealed new information on bacterial proteins such as superoxide dismutase, pili and flagellar proteins, Type Three secretion systems, and their roles in *A. salmonicida* pathogenicity. A DNA microarray of *A. salmonicida* genes is used for transcript profiling and comparative genomic hybridizations (M-CGH), whereby genomic DNA from selected *A. salmonicida* isolates, as well as other *Aeromonas* subspecies was compared with that of the sequenced strain. Results showed that variation among the virulence associated genes increased across sub-species boundaries. We are also investigating the host. Salmon were challenged with *A. salmonicida* and samples of the bacterium and the host tissues were taken at selected times post-infection. From the host, EST libraries were made from mRNA and suppressive subtractive hybridization revealed differential gene expression. An Atlantic salmon cDNA microarray was constructed to investigate the functional genomics of the host response and genes differentially expressed during the infection process have been identified. By linking genome sequencing, functional genomics, proteomics, carbohydrate analysis, metabonomics/metabolomics, and immunological assays, we are taking an integrated and innovative approach to pathogenesis research.

**PLEUROGENE: Genomics for the enhancement of commercial production of Atlantic halibut and Senegal sole**

M. Reith^{1*}, J. Cerdà², M. Matsuoka¹, H. M. Murray¹, D. Reid¹, C. Smith¹, L. Knickle¹, D. Martin-Robichaud³, M. Rommens⁴, B. Blanchard⁴ and S. E. Douglas¹

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⁴Scotian Halibut Limited, Clarks Harbour, NS, Canada B0W 1P0

Atlantic halibut (*Hippoglossus hippoglossus*) and Senegal sole (*Solea senegalensis*) are flatfish with excellent potential for aquaculture in Atlantic Canada and Mediterranean Europe, respectively. The Pleurogene project, which is funded by Genome Canada and Genoma España, uses genomic approaches to investigate important biological processes such as reproduction, development, nutrition, genetics and immunity, and applies this information to improve production of these species. 23000 ESTs have been generated (~10,000 for sole, ~13,000 for halibut), substantially increasing the amount of genetic sequence data available for both species. These sequences have been used to design species-specific microarrays containing 4550 unique genes for sole and 9260 for halibut. Microarray experiments are currently underway to investigate gene expression during larval development and sex differentiation and to investigate responses to different feeds. Additional approaches to investigating gene expression include real-time PCR and the use of a robot for high-throughput *in situ* hybridization to visualize gene expression. A medium-density genetic map has been developed for halibut that is supported by marker-centromere mapping data and that shows good correspondence to the halibut karyotype. These tools will result in enhanced fish production through selection of better broodstock and the development of improved culture technologies.



National Code System

Wednesday, November 22, 2006

10:00 AM - 12:30 PM

Location: Harbour Suite A

Chair: Jamey Smith (New Brunswick Salmon Growers' Association)

10:20 C. Bedellion

Why the Need for Codes?

10:40 S. Ford

Government perspective – smart regulation and codes

11:00 D. Rideout

National industry perspective – update on the National Code System

11:20 R. Stevenson

West coast perspective – development in BC finfish and shellfish

11:40 C. Couturier

East coast perspective – development in Atlantic Canada

12:00 E. Kearney

Farmer's experience and perspective



Orchestrating Aquaculture Research and Development

Wednesday, November 22, 2006

10:00 AM – 12:30 PM

Location: Harbour Suite B

Chair: Tim DeJager (DeJager AquaLogic)

10:20 J. Parsons

Perspectives and overview of Canadian aquaculture research and innovation

10:40 G. Taylor

Collaborative R&D: what works, what doesn't

11:00 A. Alvial

Chilean salmon cluster: evolution and prospects

11:20 Discussion – Identify Issues

11:40 D. Anderson

Experiences of the Canadian Agri-food Research Council

11:55 J. Smith

Perspective from the Canadian aquaculture industry on RD&C

12:10 R. Vaillancourt

SODIM's model for aquaculture research and innovation in Québec

Collaborative R&D: what works, what doesn't

Graham Taylor*

Vice-President, External Relations, Precarn Incorporated, 510 – 525 Carling Avenue, Ottawa, Ontario K1Z 8R9

This presentation is based on the 16-year experience of Precarn Incorporated in funding and facilitating collaborative, networked R&D. Precarn, along with other successful organizations, will be presented as examples of “4th pillar” organizations, which bring together the other three pillars of innovation: industry, universities and colleges, and government organizations. The presentation will highlight the distinctive model developed and refined by Precarn over the years, illustrating its application with reference to opportunities and challenges faced by the aquaculture industry. The model involves a technology development company as the project leader, a first user, and academic researchers in a pre-commercial project of which the principal deliverable is typically a prototype demonstrated in a user setting. Project funding is supplemented by related services, events and information. The principles will be demonstrated through examples of successful projects in other domains. The presentation will conclude with a review of success factors and pitfalls in collaborative R&D, including lessons learned by Precarn, providing the audience with an appreciation of what might work in the aquaculture sector.



SODIM's model for aquaculture research and innovation in Quebec

Robert Vaillancourt

Assistant director research and development, Société de développement de l'industrie maricole (SODIM)

The SODIM's R&D fund was created in 2002 following an agreement signed between herself and the Quebec government. The creation of the fund came at a time when Quebec's young aquaculture industry needed a tool to close the gap in some matters detrimental to its development. In fact, before the fund was created, each aquaculture enterprise was partly responsible for carrying, at its own costs, the research needed for its advancement. The fund's main goal is to unlock technological constraints and to transfer the knowledge and results which arise from activities supported by the fund to the established industry. In order to achieve these goals, the SODIM consulted the industry and mapped out an action plan which clearly identified the needs, the actions to be taken and the priorities in R&D. The action plan is updated annually following the consultation of expert-industry groups and taking into consideration the results of the research projects initiated by the SODIM or by other organisations. With these particularities, the SODIM's fund differs from other subsidiary programs (ex. NSERC, AquaNet, etc.). The fund is specifically dedicated to undertake the priority actions identified in the SODIM's R&D action plan. Since its creation, the SODIM has initiated close to 150 projects and, thanks to its financial support, allowed the creation of a marine branch within the Quebec's aquaculture network (Qan). Thanks to its status and its R&D fund, the SODIM has the opportunity to develop financial and in-kind partnerships with other organisations. For each dollar invested by the R&D fund, the SODIM concluded financial partnerships for \$1.69. This amount climbs up to \$2.84 when in-kind contribution is considered. SODIM's R&D projects are mainly undertaken by teams from the Quebec department of Agriculture, Fisheries and Food, Fisheries and Ocean Canada and university networks.

Le fonds R&D de la Société de développement de l'industrie maricole (SODIM) a été créé en 2002 suite à la signature d'un protocole d'entente entre elle et le gouvernement du Québec. L'avènement de ce fonds venait palier à certaines lacunes préjudiciables au développement de l'industrie maricole québécoise naissante. En effet, avant la création du fonds, les entreprises maricoles réalisaient elles-mêmes à l'interne et à leurs frais une part des travaux R&D requis à leur développement. Ce fonds vise la levée des verrous technologiques qui freinent le développement durable et la compétitivité de l'industrie. Il vise également le transfert, aux entreprises aquacoles établies, des connaissances et des résultats découlant des initiatives supportées par le fonds. Afin d'atteindre ces objectifs, la SODIM a élaboré, en consultation avec l'industrie, un plan d'action identifiant clairement les besoins, les actions à entreprendre et les priorités en R&D. Ce plan d'action est mis à jour annuellement par une consultation des groupes experts – industries en mariculture du Québec et en regard des résultats des projets R&D initiés par la SODIM et par d'autres organismes. Ainsi, ce fonds R&D ne s'apparente pas à un organisme subventionnaire (ex. CRSNG, AquaNet, etc.). Les sommes d'argent sont destinées spécifiquement à la mise en œuvre des actions de R&D hautement prioritaires contenues dans le plan d'action R&D de la SODIM. Depuis sa création, la SODIM a initié près de 150 projets de recherche et développement en plus d'avoir permis, grâce à son soutien financier, la création d'un volet marin au Réseau aquaculture Québec (RAQ). Le statut de la SODIM et de son fonds R&D lui donne la possibilité de créer des partenariats (financiers et en nature) avec d'autres organismes. Pour chaque dollar investi par le fonds R&D, la SODIM a conclu des partenariats financiers pour 1,69 \$. En considérant les contributions en nature, ce montant augmente à 2,84 \$. Les projets de R&D de la SODIM sont réalisés principalement par des Équipes du ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, de Pêches et Océans Canada et du réseau universitaire.



Challenges to Marine Aquaculture I – Integrated Multitrophic Aquaculture

Tuesday, November 21, 2006

2:00 PM - 3:20 PM

Location: Commonwealth A Ballroom

Chair: Chris Pearce (Fisheries and Oceans Canada)

2:00 T. Chopin

Integrated multi-trophic aquaculture (IMTA) in the Bay of Fundy, Canada: rationale and kelp cultivation as the inorganic extractive component of the system

2:20 S. Cross

IMTA and the Pacific SEA-Lab Initiative

2:40 S.M.C. Robinson

Integrated multi-trophic aquaculture (IMTA) in the Bay of Fundy, Canada: mussel cultivation as the organic extractive component and evolution of the system

3:00 B. Swift

Evaluation of an integrated polyculture system utilizing wasabi and hybrid poplar to enhance phosphorous and nitrogen removal from land-based salmon farm effluent.

Integrated multi-trophic aquaculture (IMTA) in the Bay of Fundy, Canada: rationale and kelp cultivation as the inorganic extractive component of the system

T. Chopin^{1*}, M. Sawhney¹, R. Shea¹, E. Belyea¹, S. Bastarache¹, W. Armstrong¹, G.K. Reid^{1,2}, S.M.C. Robinson², B. MacDonald¹, K. Haya², L. Burrige², F. Page², N. Ridler¹, S. Boyne-Travis³, J. Sewuster⁴, M. Szemerda⁵, F. Powell⁵ and R. Marvin⁵

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There is a renewed interest in combining seaweed and shellfish aquaculture (as the inorganic and organic extractive components) with fed finfish aquaculture to create integrated multi-trophic aquaculture (IMTA) systems for environmental biomitigation, economic diversification and increased social acceptability. We are developing such a system by co-cultivating salmon (*Salmo salar*), kelp (*Laminaria saccharina* and *Alaria esculenta*) and blue mussel (*Mytilus edulis*) at several aquaculture sites in the Bay of Fundy. Kelp culture techniques have been improved both in the laboratory and at the aquaculture sites. Increased growth rates of kelps (46%) cultured in proximity to fish farms reflect the increase in food availability and energy. Nutrient and biomass levels are being monitored to model the biomitigation potential of an IMTA site. Over 5 years, none of the therapeutants used in salmon aquaculture have been detected in kelps collected from the IMTA sites; levels of heavy metals, arsenic, PCBs and pesticides have always been below regulatory limits. We are now scaling-up experimental systems and working on an appropriate food safety regulatory and policy framework for the development of commercial scale IMTA operations. Site selection for the best compromise between site characteristics, species selection, and market demands will be key to optimizing IMTA.



IMTA and the Pacific SEA-Lab Initiative

S. Cross

University of Victoria, Victoria, BC

British Columbia is taking an active role in assessing the socio-economic and environmental benefits of integrated aquaculture systems. Sustainable Ecological Aquaculture (SEA) system design and performance trials are currently being conducted at a small, commercial-scale facility in Kyuquot Sound. This presentation provides some of the background research leading to this avenue of system development, BC's role in a national and international SEA-Lab research network, our Pacific R&D plans for the next few years, and the vision for these systems in our future aquaculture industry.

Integrated multi-trophic aquaculture (IMTA) in the Bay of Fundy, Canada: mussel cultivation as the organic extractive component and evolution of the system.

S.M.C. Robinson^{1*}, T. Lander^{1,2}, J.D. Martin¹, A. Bennett², K. Barrington², G. Reid^{1,2}, T. Blair¹, T. Chopin², B. MacDonald², K. Haya¹, L. Burrige¹, F. Page¹, N. Ridler², S. Boyne-Travis³, J. Sewuster⁴, F. Powell⁵ and R. Marvin⁵

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IMTA involves the combination of fed and extractive forms of aquaculture to form a customized biological system where the net output of the aquaculture production is reduced to a level where, ideally, there is no discernable negative impact on the surrounding ecosystem. The organic loading that occurs from an aquaculture site can be quite diverse and span five orders of magnitude in particle sizes. These size classes have different physical properties in particle dynamics and also differ in the suite of organisms that can handle and process them. As a result, the design of the IMTA system to handle the organic loading is understandably complex. Our work to-date on the small organic particulates (<100 µm) has shown that there are local increases in seston loading close to the aquaculture sites, but that the loading decreases quickly away from the site. Those organisms (e.g. the blue mussel, *Mytilus edulis*) that are within this locally enriched zone have experienced faster growth rates and altered reproductive cycles. The potential economic return from this particular bio-filter module is of significant interest to the existing salmon-culture industry and government regulators. Other species are currently being considered for their trophic fit to this project.



Evaluation of an integrated polyculture system utilizing wasabi and hybrid poplar to enhance phosphorous and nitrogen removal from land-based salmon farm effluent

B. Swift ^{*1}, D. Ehret ², D. Noakes ³ and C.M. Pearce ⁴

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Most land-based fish farms in B.C. release fish effluent to the environment on an ongoing basis. The objective of this study was to examine the potential for growing wasabi (*Wasabi japonica*) and hybrid poplar (*Populus* sp.) in fish farm effluent to reduce dissolved mineral release (P and N) into the environment. Both species were grown using trickle irrigation or sub-service irrigation methods for both control and effluent water treatments. Wasabi grew to a marketable size within 16 months but was considered to be poor at removing soluble N and P due to its slow growth rate and small size. Hybrid poplar were harvested at 15 months and determined to have greater potential for N and P scrubbing than wasabi due to higher growth rates. This study indicates that wasabi and hybrid poplar can utilize nutrients from the effluent of freshwater land-based aquaculture facilities. It also demonstrates that these two species could be developed as secondary cash crops utilizing waste byproducts from freshwater aquaculture.



Challenges to Marine Aquaculture III – Open Ocean Aquaculture

Wednesday, November 22, 2006

3:20 PM – 4:25 PM

Location: Commonwealth A Ballroom

Chair: Tim Jackson (National Research Council – IRAP))

3:20 T. Jackson
Introduction

3:25 T. Jackson
US cooperation in open ocean developments

3:45 M. Chambers
Recent developments at the University of New Hampshire Open Ocean Aquaculture Project

4:05 C. Bridger
Recent development in Atlantic Canada



Recent developments at the University of New Hampshire Open Ocean Aquaculture Project.

Chambers, M.D.^{1*}, R. Langan², W.H. Howell³, B. Celikkol⁴ and R. Barnaby⁵.

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Technological advances in open ocean aquaculture continue at the University of New Hampshire (UNH) experimental farm 10 km offshore in the Gulf of Maine. A submerged mooring platform, 20 m below the surface, maintains experimental fish containment systems, automatic feed buoys, fish tracking instrumentation and environmental monitoring equipment. Last spring, 50,000 Atlantic Cod (*Gadus morhua*) produced by Great Bay Aquaculture were stocked in a 3000 m³ Sea Station cage at a mean weight of 35g. They are currently being fed twice per day at 1.25% body weight with a solar and wind powered feed buoy. Cod are studied by means of underwater video cameras, an acoustic tag receiver and four fixed hydrophones. Observations indicate that cod behave independent of each other, swam on average .15-1 body length per second and do not feed every day when food is presented. Methods for submerged mussel culture (*Mytilus edulis*) have been successfully demonstrated and transferred to two commercial farms in State waters. Production capacities for these sites are estimated at 420 ton by 2008. Novel sub sea fish cages have been numerically modeled and field tested offshore in the grid. They include a 500 m³ AquaPodTM cage developed by Ocean Farm Technologies and a 1300 m³ net pen constructed by JPS Industries. Both systems endured and survived energetic sea conditions at the site. A 20 ton ocean feed buoy designed by UNH and Ocean Spar is under construction at AEG/HSC Fabrication in Weldon, NB. Operating and control systems will be evaluated near shore before the buoy is towed to the UNH site in spring of 2007. The buoy will hydraulically supply daily feed rations and serve as a communication platform for real time video and environmental data back to the main campus in Durham, NH. Present and future research activities from the NOAA supported project will be presented.



Animal Health and Welfare

Wednesday, November 22, 2006

2:00 PM – 4:40 PM

Location: Harbour Suite A

Chair: Jim Duston (Nova Scotia Agricultural College)

- 2:00 A. Venoit**
Health monitoring of American oysters, *Crassostrea virginica*
- 2:20 M. Mills**
Health management practices: Marine Harvest
- 2:40 J. Lumsden**
Viral hemorrhagic septicemia virus type IV in the Great Lakes
- 3:00 R.D. Moccia**
I swim therefore I am? Issues on the welfare of farmed fish
- 3:20 K. Soanes**
Zebrafish: a model organism for studying host-pathogen interaction in cultured fish species
- 3:40 V. Pedersen**
National Aquatic Animal Health Program: current status and direction
- 4:00 D. MacCallum**
British Columbia Shellfish Aquatic Animal Health Program
- 4:20 M. Beattie**
ISA disease in NB, surprising opportunities, and significant changes
-

The Marine Harvest Canada Strategy for Effective Fish Health Management

Meghan Mills*, Diane Morrison, Brad Boyce and Cilka LaTrace

Department of Fish Health and Food Safety, Marine Harvest Canada, 1211 Cypress Street, Campbell River, BC, Canada, V9W 2Z3

Fish Health is vital for successful salmonid aquaculture. In fact, without undermining other aspects of the industry, fish health is the key issue upon which everything else is dependent. A poor and neglected fish health program may lead to reduced production, increased labor costs and increased expenses due to treatments. In addition, sites with compromised fish health management may lead to increased risk of disease transmission between wild populations and farm stocks. Marine Harvest Canada recognizes the importance of an effective fish health management program. Our strategy is a holistic approach and involves all aspects of our business such as; surveillance and investigation of fish health issues, medical care, treatment when necessary, selective breeding, fish health and biosecurity training for all staff, environmental analysis, clinical/field research, development and delivery of policies. Our goal is to meet and exceed current fish health regulations and ultimately protect our stocks.



Viral hemorrhagic septicemia virus type IV in the Great Lakes.

JS. Lumsden^{*1}, S. Russell¹, K. Young¹, L. Al-Husseini¹, A. Yazdanpanah¹, P. Huber¹, B. Morrison², C. Yason³, Stone⁴, K. Way⁴.

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⁴CEFAS Weymouth Laboratory, Barrack Rd. The Nothe, Weymouth, DT4 8UB, UK.

In April and May of 2005, large numbers of dead and dying freshwater drum were observed in the Bay of Quinte (Lake Ontario). Moribund fish were lethargic and exhibited extensive hyperemia and hemorrhages with bilateral exophthalmia, often with hyphema. Copious serosanguinous coelomic fluid and gastrointestinal hyperemia/hemorrhage were seen. Wet mounts were unrevealing and no bacteria were cultured. Consistent histologic lesions included a fibrinoid vasculitis, a severe necrotizing myocarditis, epicarditis, meningoencephalitis and enteritis. All mouse inoculations using pooled tissues were negative for botulism toxin. Numerous clusters of viral particles with typical rhabdovirus morphology ~70x160nm were present in myocardial tissue and in FHM supernatant examined by TEM. RNA polymerase gene sequence indicated the virus to be 91% homologous to a viral haemorrhagic septicemia virus isolate from Japan (type IV strain). In Michigan, VHSV was isolated from Lake St. Claire muskellunge later that spring and retrospectively as early as 2003. In Spring 2006, mortality events occurred in Lake Ontario, Erie and St. Claire in the U.S.A. and Canada affecting yellow perch, freshwater drum, gizzard shad, and round goby but also walleye, burbot, muskellunge, smallmouth bass, and several other species. All viral isolates obtained to date are genetically identical and have been proposed to be a new sub-group. The impact to freshwater fish in the Great Lakes and beyond has yet to be realised.

I Swim Therefore I Am? Issues On the Welfare of Farmed Fish.

R.D. Moccia^{*} and S. Yue

Aquaculture Centre, Department of Animal and Poultry Sciences, University of Guelph, Guelph, ON N1G 2W1

The welfare status of captive livestock is an important determinant of society's overall acceptance of farming technology and its products, and of agrifood production systems in general. Unlike those animal species used in terrestrial agriculture, there is a paucity of scientific information concerning the welfare of intensively farmed teleost fish. Accordingly, fish production in North American and EU countries has come under recent criticism by humane societies, animal welfare and activist groups, and also by more mainstream sectors. Aquaculture utilises a number of husbandry technologies which may need to be examined from a welfare perspective such as: high density rearing, various health management protocols, aggressive feeding strategies and feed formulas designed to produce very rapid growth, slaughter and transport techniques, and genome manipulation to name a few. These potentially controversial management practices may threaten both the individual animal, as well as the future of the aquaculture industry. This presentation will provide insight into these controversial issues, as well as examine the latest developments in the scientific community that may be used to assist in the determination of those acceptable captive conditions in which farm animals live. The primary goal is to help ensure the sustainable growth of fish farming in Canada.



Zebrafish: a model organism for studying host-pathogen interaction in cultured fish species.

Kelly Soanes*

National Research Council - Institute for Marine Biosciences, Halifax, NS B3H 3Z1

The popular freshwater aquarium species, *Danio rerio* (the zebrafish), has become an accepted model organism for many different areas of research from development biology to pharmaceutical discovery. More recently the zebrafish has captured the interest of aquaculture researchers worldwide and has been recognized as an emerging model for understanding issues applicable to this industry including stress, nutrition, growth and disease prevention. Many farmed fish species are subject to culture conditions that increase the animals' exposure to certain pathogens, stress-induced immunosuppression and consequently disease. Compared with mammals however, little is known about the complex immune response mounted by these various species. With numerous genetic lines, a short generation time, small size, rapid development, a sequenced genome, the availability of genomic resources and being amenable to genetic manipulation the zebrafish lends itself nicely to understanding these conserved processes in the context of the intact animal. At the National Research Council – Institute for Marine Biosciences (NRC-IMB) we are utilizing the versatility of this model organism to understand the function and regulation of novel immune-relevant genes identified from Atlantic salmon (*Salmo salar*). Since much of the immune system has been conserved throughout vertebrate evolution, these studies will undoubtedly help unravel the function of these genes *in vivo*, not only in zebrafish but in other teleosts as well. The presentation will include a brief overview outlining current and potential applications for the zebrafish as a model for aquaculture research, along with a summary of our ongoing research projects and interests at NRC-IMB.

National Aquatic Animal Health Program: Current Status and Direction

Victoria Pedersen^{1*}

¹Canadian Food Inspection Agency, St. George, New Brunswick, CANADA E5C 3S9

Canada's National Aquatic Animal Health Program is a science-based regulatory program for aquatic animal diseases. The NAAHP is designed to protect Canada's aquatic resources from the introduction or spread of certain infectious diseases into or within Canada, maintain access to international seafood markets, preserve consumer confidence in the country's seafood safety, as well as demonstrate Canada's aquatic animal health status. The key components of the NAAHP are: legislative authority under the Health of Animals Act, aquatic animal disease list, surveillance, zonation, disease control measures, import controls/export certification based on risk assessment, a disease database, laboratory diagnostic testing and quality assurance/quality control. The program is led by the Canadian Food Inspection Agency (CFIA) and co-delivered with Fisheries and Oceans Canada (DFO). The NAAHP is a collaborative effort which could not be successful without the support of the provinces, territories, academe and industry. This presentation will provide a synopsis of the NAAHP, outline its' current status and the program direction.



British Columbia Shellfish Aquatic Animal Health Program

David McCallum

Research & Development Coordinator, British Columbia Shellfish Growers Association (BCSGA), Unit F 2002 Comox Avenue, Comox, BC, Canada, V9M 3M6, E-mail: david@bcsga.ca

In 2002, the World Organization for Animal Health (OIE) implemented mechanisms that require shellfish exporting countries to attest to the disease-free status of the animals being exported. The absence of an established shellfish Aquatic Animal Health Program (AAHP) in British Columbia resulted in a trade disruption with the European Union (EU) in 2004. Subsequently, BC shellfish producers have lost in excess of \$1.4 million in sales since 2004. To re-establish access to the EU markets and to prevent placing all shellfish export sales at risk, the BC shellfish aquaculture industry must take the necessary steps to develop and implement a credible AAHP. A Canadian Food Inspection Agency (CFIA) led, two-year pilot surveillance project commenced in the fall of 2006. This presentation will simply describe the BC shellfish AAHP as an industry driven, economic initiative, and will provide an update on progress to date.

ISA Disease in NB, Surprising Opportunities, and Significant Challenges

Michael J. Beattie

NB Dept. of Agriculture and Aquaculture

ISA has been the scourge of the salmon farming industry in NB since 1997. Many steps have been taken by both government regulatory bodies and industry to limit the negative effects and gain some control over this virus. Challenges involving husbandry practices, diagnostic tests, laboratory QC/QA, sampling techniques, depopulation thresholds, wharf usage, harvest vessels, processing plant effluent treatment, and fallowing have been ongoing since the initial outbreak. Government and industry have established an ISA Control and Containment document to slow the spread of the disease between year classes and adjacent zones. All of the aforementioned have served to strengthen the industry as whole, however many challenges still confront the aquaculture industry. This presentation will address some of the gains that have been made and also point out the genotypic variations observed in ISAV.

One new bright light is the new Director of the VDD, who understands the limitations for industry to acquire new drugs and vaccines due to the relative size of the market. VDD in cooperation with CFIA and DFO have allowed NBDAA to carry out an extensive field trial on the withdrawal time for SLICE (emamectin benzoate). AVC field personnel and NBDAA have been amassing temporal residue data for multiple farms at various water temperatures. Some of this field data will be included in this presentation.



Orchestrating Aquaculture Research and Development (Continued)

Wednesday, November 22, 2006

2:00 PM – 4:00 PM

Location: Harbour Suite B

Chair: Tim DeJager (DeJager AquaLogic)

2:00 B. Meaney

Provincial perspective on enhancing aquaculture research and innovation in Canada

2:15 P. Warris

Linking research to industry needs for development and innovation

2:30 C. Audet

Réseau Aquaculture Québec: Building bridges with our local organizations and the Québec industry

2:45 T. DeJager

Mobilizing knowledge: AquaPort and the AAC Science Advisory Forum

3:00 Discussion 2 – Strategies and Solutions

Réseau Aquaculture Québec: how we established collaborations with local organizations and Québec's aquaculture industry

C. Audet

Institut des sciences de la mer de Rimouski, Université du Québec à Rimouski, Rimouski (Qué.) G5L 3A1

The Réseau Aquaculture Québec (RAQ) was first set up by a few researchers involved in freshwater aquaculture studies who endeavoured to interest other scientists in problems related to this growing field. The network's research program first concentrated on the issue of phosphorus discharge from fish farms and the biological aspects of charr culture. From the beginning, we worked on attracting colleagues who could integrate socio-economic and legal aspects to the studies in progress. Within a short time, the network included Québec government researchers and academics interested in freshwater and marine aquaculture. With its partners—government organizations, SODIM, and SORDAC—the RAQ succeeded in setting up a provincial, inter-institutional, and multidisciplinary research network sensitive to the industry's problems without denying a vision that must emphasize research activities. Our research program is now based on four axes—environment, functional genetics, nutrition, and health—that combine socio-economic, legal, and ethical aspects. Our goals are 1) a closer integration of freshwater and marine expertise, 2) a consolidation of relationships with our partners, and 3) diffusion of our research results in accessible forms.



Mobilizing knowledge: the AquaPort.ca and the AAC Science Advisory Forum

T. DeJager^{1*}, B. Pennell²

¹DeJager AquaLogic, 115 Gibraltar Rock, Nanaimo, BC V9T 4M3

²Acting Director, Institute for Coastal Research, Malaspina University-College, Nanaimo, BC V9R 5S5

The AquaPort.ca Project and the AAC Science Advisory Forum are two initiatives that share a common premise: enabling people to more easily find, understand and apply information that will help industry innovate and contribute to better public understanding. Industry, researchers, government, and the public need a trusted source of knowledge. AquaPort, which will launch in June 2007, is a national project, funded by AquaNet and other partners. Its aim is to create a user-friendly, one-stop web “portal”, powered by a database that will enable users to find and access information quickly and efficiently. Research projects and results, government documents, new technology, market information, and management are just some of the areas it will cover. The AAC has undertaken a similar but more specific mission through the Science Advisory Forum - to provide people with a more complete picture of aquaculture issues of concern by using the best Canadian scientists in the field to help put the research story together. This collective scientific input is drafted into a “fact sheet” that can be accessed by anyone interested in the issue. The first story on sea lice is now posted on the AAC website with others soon to follow.



Shellfish Health – Contributed Papers

Wednesday, November 22, 2006

4:00 PM – 5:00 PM

Location: Harbour Suite B

Chair: TBD

4:00 S. Belvin

Health survey of marine bivalves from cultured and experimental sites in the province of Quebec

4:20 B. Genard

Bacterial challenge on oyster larvae (*Crassostrea virginica*): biochemical and genomic responses

4:40 L. Frechette

Studies of the abundance of the caprellid on mussel spat collectors and its effect on mussel spat

Health survey of marine bivalves from cultured and experimental sites in the province of Quebec.

S. Belvin^{*1}, R. Tremblay², C. Cyr³ and B. Thomas⁴

¹Université du Québec à Rimouski et Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, Centre Aquacole Marin de Grande-Rivière, Grande-Rivière, QC, G0C 1V0

²Institut des sciences de la mer, Université du Québec à Rimouski, Rimouski, QC, Canada G5L 3A1

³Pêches et Océans Canada, Institut Maurice-Lamontagne, Mont-Joli, QC, G5H 3Z4

⁴Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, Centre Aquacole Marin de Grande-Rivière, Grande-Rivière, QC, G0C 1V0

Shellfish culture is in effervescence in the Quebec province. Technological innovation enables the increase of production volumes and helps to sustain the constant growing demand. New techniques like spat transfer also permits to improve the performance of culture farms. These transfers must be safely executed in order to avoid disease propagation that could strongly affect the production and also the native shellfish of the culture site. That is why a health survey has been conducted on marine shellfish from different culture and experimental sites in Quebec in 2004 and 2005. The targeted species were blue mussels, *Mytilus edulis*, softshell clams, *Mya arenaria*, giant scallops, *Placopecten magellanicus* and Iceland scallops, *Chlamys islandicus*. The main objective of this project was to establish a data base that is essential to accurately differentiate primary pathogens and opportunistic ones' taking advantage of sub-optimal culture conditions. Histological examination revealed the presence of organisms such as gills, digestive gland and intestine ciliates, *digenean metacercarian* cysts, *Rickettsia*-like organisms and copepods. Pathology or pathogen observed such as *Prosoorhynchus squamatus* and haemic neoplasia are disease concern in Atlantic Canada and require a stronger monitoring.

**Bacterial challenge on oyster larvae (*Crassostrea virginica*): biochemical and genomic responses.**

Genard B.*¹, Pernet F², Tremblay R.¹, Moraga D.³, and Lemarchand K.¹.

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²IRZC, Institut de recherche des zones côtières, Shippagan. NB. E8S 1J2

³IUEM, Institut universitaire européen de la mer. LEMAR, Laboratoire des sciences de l'environnement marin.

UBO, Université de Bretagne Occidentale. CNRS, Centre national de la recherche scientifique. Plouzané, 29280 Brest (France)

Bivalve larvae often experience high mortalities during their protracted larval development due to outbreak of opportunistic bacteria. Therefore, the understanding of the relationship between opportunistic bacteria and larvae is important for the success of hatchery operations. This study examines the performance of American oyster from egg to pediveliger stages in relation to the bacterial community profiling in the larval tanks, the lipid dynamic of larvae and gene expression. Chloramphenicol addition have strongly limited mortality until pediveliger stage. Losses during the planktonic larval period occurred primarily during late veliger stages (d13 to 20) as previously observed on other bivalve species. Groups of larvae reared without antibiotic showed massive mortality presumably reflecting the emergence of pathogenic bacteria. Preliminary analyses showed that the expression of genes related to immune response, stress response, lipid metabolism and cell communication was strongly influenced by mortality event and seawater treatment (antibiotic vs. control).



Poster Abstracts – Aquaculture Canada^{OM} 2006

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

An exploratory examination of current and potential aquaculture sites to determine the risk of aquatic invasive species in Newfoundland

Terri Baines*¹, Cynthia McKenzie¹ and Derek Mouland²

¹ Aquaculture Section, Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada, St. John's, NL, Canada, A1C 5X1

² Department of Fisheries and Aquaculture, Government of Newfoundland and Labrador, Grand Falls-Windsor, NL

Fisheries and Oceans Canada has initiated an Atlantic Canada Zonal study to determine the distribution and abundance of aquatic invasive species (AIS) that present a risk to the aquaculture industry. In the Newfoundland and Labrador region, they have partnered with the Provincial Department of Fisheries and Aquaculture who have an established AIS monitoring program, to provide a more detailed examination of current aquaculture sites as well as potential sites in the Placentia Bay area. Twenty-four AIS moorings have been placed at 8 aquaculture sites, three at each site, near the provincial AIS collectors. The moorings have 6 PVC plates, 3 horizontal and 3 vertical at varying depth to detect variation in substrate and vertical distribution of biofouling organisms and potential AIS. The plates are deployed for 20 weeks and over the winter. The plates are being analyzed for invertebrate invasive species including ascidian tunicates, crab, ghost shrimp and bivalves and biofouling and invasive macroalgae. An additional 33 moorings have been deployed at 11 potential mussel seed collection sites in Placentia Bay. Additional environmental data (temperature, salinity, chlorophyll) was collected to provide ecosystem context for the species identified as well as current profiles (Acoustic Doppler Current Profiler) of selected areas to determine the likely spread of AIS if established. Biodiversity of these biofouling organisms is being catalogued by both partners to provide a record of native and invasive species.

Growth, survival and physiological conditions of hatchery-reared American oyster larvae (*Crassostrea virginica*) in relation to water treatments and diet

France Béland*, Chantal Gionet, and Fabrice Pernet

Institut de Recherche sur les Zones Côtières Inc., Université de Moncton, Shippagan, Nouveau-Brunswick, Canada E8S 1J2

Bivalve larvae often experience high mortalities during their protracted larval development. This study examines the performance (survival, growth and lipid class and fatty acid changes) of American oyster from egg to postlarval stages as a function of water treatments. The seawater was treated with ozone and/or with UV following a 2×2 factorial experiment. Larvae were fed a mixture of *Pavlova lutheri* (MONO), *Isochrysis galbana* (TISO) and *Chaetoceros gracilis* (CHGRA). CHGRA was introduced either at day 2 post-fertilization (dpf) or at 7 dpf. Preliminary results showed a significant interaction ozone × UV × diet on the survival of larvae. The use of UV-treated seawater reduced the survival of oyster larvae fed the ternary diet at 7 dpf whereas it has no effect on the survival of larvae fed the ternary diet at 2 dpf. In contrast, the use of ozone reduced the survival of oyster larvae fed the ternary diet at day 2. Here, we hypothesized that the introduction of CHGRA could have influenced the bacterial community profile of the seawater, which has a strong influence on the effect of water quality on survival of oyster. The possible probiotic effect of phytoplankton associated-bacteria in relation to water treatment will be discussed.



Bacterial profiling leads to the development of a treatment for improving haddock larval survival

Benjamin S. Forward^{1*}, Baijing Ji¹, Douglas McIntosh³, Rémy Haché², Fabrice Pernet², Rachael Ritchie¹.

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² Coastal Zone Research Institute Inc., 232-B avenue de l'Église, Shippagan NB, E8S 1J2

³ Laboratory of Recombinant Technology, Biomanguinhos, Oswaldo Cruz Foundation, Rio de Janeiro, Brazil.

Analysis of the bacterial microflora associated with aquaculture rearing systems can yield important information about the health of the particular species being cultivated and the suitability of the existing culture conditions to maintaining good health. Bacterial profiling of haddock larval (*Melanogrammus aeglefinus*) rearing systems has led to the discovery of important information about the succession of bacterial species associated with healthy developing larvae and permitted the isolation of several species of bacteria with properties that suggest they may be useful when applied as a probiotic treatment to culture systems. Haddock larvae treated during the early stages of development with one of these isolates, L68, has shown a 76% and 139% increase in survival over controls in duplicate trials. Interestingly, larvae treated with L68 also showed an altered microbial succession profile compared to controls such that species associated with healthy larvae appeared earlier in development. Together these results suggest that L68 is capable of increasing larval survival by influencing the natural succession and development of bacterial microflora in haddock larvae.

Do winter flounder (*Pseudopleuronectes americanus*) larvae grow differently in a cold environment depending on parental origin?

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Winter flounder (*Pseudopleuronectes americanus*) is a common flatfish found in coastal waters of the northwest Atlantic from Georgia (USA) to Newfoundland (Canada). Three stocks are currently defined: one south of Cape Cod, one north of Cape Cod, and a third on Georges Bank. Not much information is available regarding potential differences among fish from northern locations. Our objective was to verify if populations from different Canadian origins have similar larval development characteristics in a cold-water environment. We crossed breeders from Passamaquoddy Bay, NB (PB), the St. Lawrence estuary, QC (ES), and Baie des Chaleurs, QC/NB (BC), that were captured on their natural spawning sites and reared the larvae under salinity and temperature conditions of the St. Lawrence estuary (12L:12D). Total length (TL) and total width (TW) were measured from hatching to settlement. Larvae from BC and ES grew faster than PB larvae, which suggests that larval growth performance may be related to parental origin. The next step will be to test for a sire effect on larval development and cold-water tolerance of juveniles.



Lipid remodelling in gills and metabolic effects in the adductor muscle of oyster *Crassostrea virginica* in response to repeated thermal fluctuations.

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In New-Brunswick, floating oyster bags are one of the main techniques to grow oysters. Nevertheless organisms usually have to sustain daily thermal fluctuations as high as 15°C. Such thermal stress may engender an increase of energy demand and the induction of cell defence mechanisms to face cell damages. A variable balance between anaerobic and aerobic metabolism in the adductor muscle could also be expected to insure cellular integrity in such changing and stressful conditions. In our study, adult oysters were experimentally exposed seven successive times to daily thermal fluctuations between 12°C and 25°C (a 12h increase followed by a 12h decrease). Two control groups were also acclimated at 12°C or 25°C. Then we assessed in gills the oxidative stress and membrane fatty acids composition and in the adductor muscle the balance between the aerobic and anaerobic metabolism. Preliminary results do not show any effect of thermal stress on the balance between the aerobic (CCO, citrate synthase) and anaerobic metabolism (LDH, STRDH) in the adductor muscle during the first and the seventh fluctuation period. Nevertheless we report a major remodelling of lipids in gills all along the thermal fluctuations as predicted by homeoviscous adaptation theory. This remodelling involves a response of 22:6 and 20:5.

Expression and refolding of recombinant hepcidin from Atlantic salmon *Salmo salar*.

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Hepcidin is a cysteine-rich cationic antimicrobial peptide first isolated from humans and since identified in other species. This project focuses on the recombinant expression of two hepcidin-like homologues identified in Atlantic salmon, *Salmo salar*. Both contain 25 amino acids, 8 of which are cysteines believed to form 4 disulphide bonds. Both peptides are likely to possess antimicrobial activity although their specificities may differ. Recombinant Sal-1 and Sal-2 are currently being expressed in the inclusion bodies of *Escherichia coli*. Several constructs have been produced to optimize their identification and aid in refolding. The inclusion of a His tag has been found to be essential for the expression of Sal-1 as a construct lacking the tag appeared to have toxic effects on the host. Currently different methods of refolding are being optimized including on-column and dilution refolding. Due to hepcidin's small size and numerous disulphide bonds, this protein has proven difficult to work with and many steps have been required to maintain it in solution. The number of disulphide bonds formed will be determined by mass spectroscopy and eventually the structure will be analyzed by NMR. Once correctly folded, the protein will be tested against a variety of fish and human pathogens to determine its antimicrobial effects.



Study the usage of rotifer (*Brachionus plicatilis*) in (*Acipenser persicus*) date in larval stage

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This is study feeding treatment performed for 11 days to calculate the best diet in Persian Sturgeon *Acipenser persicus* to increase in production and survival rate of the larvae. In this Experiment, 4 treatments carried out (each treatment by 3 frequencies). The treatments were as follow: 1- Artemia nauplius InstarI 100% (control treatment), 2- Artemia nauplius 75%, *Brachionus plicatilis* (S- type) (Muller) 25%. 3- Artemia nauplius 50%, *Brachionus plicatilis* 75% and. 4- Artemia nauplius 25%, *Brachionus plicatilis* 75%. The larvae were fed daily 25-30% of biomass in 6 times. Physico-chemical factors of water analyzed by correlation coefficient and comparison between treatments by Duncan's test and two- way variance analysis ($p < 0.05$). During the 3 biome tries conducted during feeding period, the rate of weight increase (WG), condition factor, daily growth (Gr) and body mass were investigated. The results showed that in the first week, there was significant differences in weight increase at 5% level ($p < 0.05$), but the other mentioned factors indicated no significant differences in the biometries. The results of the experiments showed the best growth in the treatment No.4 which the mean weight and growth was 41.1 ± 0.04 mg and 6.69%, respectively. Treatment No.4 contains 25% Artemia nauplius and 75 % *Brachionus plicatilis*. We conclude that it is possible to raise *A. persicus* up to the day 7 with a mixed diet of rotifer and Artemia nauplius

Study on food composition of the sturgeons in the continental part of the Caspian Sea

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Sturgeons are one of the most important & valuable species in Caspian Sea which belong to ancient species that call them live fossil. The objective of this study is to determine the major & minor feeds of sturgeons in continental shelf and their rule on biodiversity of sturgeons in Caspian sea. To investigate feeding of sturgeons carried out by cooperative seines in 7 stations having various geographical length and width with 55 km distance from each other. Also, trawl net with 9m width & 24m length with 8mm mesh size used and sturgeons caught by motor boats in different depth of 2-4, 5-7 and 8-10 m in these stations during various seasons in 1999 to 2000. Samples prepared by sturgeons. The average minimum and maximum of their total length was 10 to 40 cm which 281, 13, 12 and 9 pieces of them were *Acipenser persicus*, *Huso huso*, *Acipenser nudipectus* and *Acipenser gueldenstaedti*, respectively. Regarding the abundance of sturgeons in regions 10m depth, high abundance of polychaeta stomach content of these fishes show the importance of this organism as the main food of sturgeon. their high abundance were due to the following factors 1) increase in the factors of oxygen reduction and resistance of polychaeta compared with other aquatic invertebrates 2) increase in water level of Caspian sea up to 2.2m in 1977 to 1992 which caused to transfer these animals to shallow regions. Finding show that crustacea used minor food for sturgeons of under one year and 2 years old.



Gonadal formation and development of cultured chub mackerel for the surrogate reproduction of bluefin tuna

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Recently, surrogate reproduction by using the technology for producing germline chimeras has been advocated for preserving the genetic diversity of the brood stock. The bluefin tuna culture, in particular, has faced problems in this regard because the spawners required for the alteration of generation are extremely limited. We used a comparatively small scombrid species the chub mackerel *Scomber japonicus* as the recipient for the surrogate reproduction of scombrid fish. We report the following three reproductive processes of the chub mackerel, namely, the joining of the primordial germ cells (PGCs) in the genital ridge, formation and differentiation of gonads, and development of germ cells. PGCs are located at the surface of the peritoneal epithelium or mesentery on the back side of the abdominal cavity immediately after hatch out. These PGCs gradually move along the epithelium toward the genital ridge by 20 dph. Some PGCs invaded the genital ridge at 20–25 dph. The gonad somatic index (GSI) increased along with growth and it was 0.01% in both sexes at 30 dph. At 160 dph, the GSI was 0.32% in females while it was 0.04% in males. From 40 dph, the upper and lower edges of the ovary elongated and formed the ovarian cavity, and a few meiotic oocytes could be seen within it at 50 dph. At 60 dph in the perinucleolus stage, most of these were 50 µm in diameter and grew to a diameter of 90 µm at 160 dph. In the testis, the spermatogonia located at the circumference of the gonad primordium at 50 dph increased in size at 70 dph, developed into the spermatocyte and spermatid at 100 dph, and became the spermatozoon that had completed spermiogenesis at 160 dph. At 370 dph, the female and male GSI were 8.6% and 12.1%, respectively, and ovulation and spermiation were observed.

Improvements in blue mussel (*Mytilus edulis*) farming operations: results from a 4-year R&D programme in Québec, Canada

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In Québec, mussel growers recently adopted the continuous socking technology from New Zealand. An R&D programme was set up in order to solve the difficulties of the mussel farmers and to improve the yields on the farms. The first step of the programme was to compare the efficiency and the cost of the different culture ropes available on the market. Used polypropylene ropes from the fishing industry proved to be the best and most economical choice. The second step was to compare the impact of the socking density on the final yield. Whereas continuous socking technology allows for a better control of seed density in mussel sleeves, there are still uncertainties on the optimal numbers in the context of Québec. Results from our experiments show that a socking density of 350 seed (12-24 mm) per foot gives better yield than 150 or 250 seed per foot. Finally, the third step was to assess the impact of warm waters on socking operations. Results show that the final yield is lower when socking 24-36 mm mussel in August whereas the schedule of socking operations makes no difference when working with 12-24 mm seed.



Cloning, binding properties, and tissue localization of rainbow trout (*Oncorhynchus mykiss*) ladderlectin.

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The primary structure, expression and immunohistochemical localization of rainbow trout ladderlectin (RTLL) were determined. Two rainbow trout cDNAs (504 and 546bp) and a genomic sequence (2kb) encoding a multimeric, serum lectin were amplified using ladderlectin specific primers. Predicted amino acid sequences were identified as group VII mannose binding C-type lectins showing highest identity with the Atlantic salmon mannose-binding lectin. The two cDNA sequences (RTLL-1 and RTLL-2) had 92% identity and encoded 173 and 187 amino acids respectively. The genomic sequence of RTLL, obtained by PCR, was found to encompass 6 exons and 5 introns, with exon 2 encoding 14 amino acids that were exclusive to RTLL-2, while Southern blots analysis revealed the presence of two or more RTLL genes. The relative expression of both transcripts was highest in the caudal kidney, while the intestine, gill and skin exhibited higher relative RTLL-2 expression than RTLL-1. RTLL was immunohistochemically present within individual cells of the gill, hepatic sinusoids, bile ducts, renal interstitium, skin, and sub-mucosal granular layer of the intestine. Two dimensional SDS-PAGE and Western blot analysis of whole plasma and plasma proteins which bound chitin and intact bacteria revealed RTLL proteins ranging in size from 16 – 18 kDa with iso-electric points ranging between pH 4.9 – pH 5.8. RTLL is a group VII C-type lectin with multiple isoforms that bind pathogen associated molecular patterns such as chitin and microbial surfaces.

Bacterial-binding activity and plasma concentration of ladderlectin in rainbow trout (*Oncorhynchus mykiss*).

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Most evidence for the defensive function of soluble lectins is derived from mammals, but severally functionally homologous, but less well-characterized, lectins have been identified in fish. In this study, we compared binding of rainbow trout plasma ladderlectins to relevant, intact bacterial targets. A polyclonal antiserum raised against a synthetic peptide identical to the 15 N-terminal amino acids of the reduced 16 kDa rainbow trout ladderlectin subunit was used to detect plasma ladderlectins in immunoblots and indirect enzyme-linked immunosorbent assay (ELISA). Ladderlectin binding to *Aeromonas salmonicida* subsp. *salmonicida*, *Aeromonas hydrophila*, *Yersinia ruckeri* and *Pseudomonas* sp. was detected by PAGE and immunoblots of saccharide elutions from intact bacteria incubated in the presence of normal trout plasma. Although plasma concentrations of immunoreactive ladderlectin were low in the majority of trout, significant ($p < 0.0001$) variation between individual fish was observed in two separate populations. In addition, one population demonstrated a subset of individuals whose ladderlectin levels were approximately seven-fold higher than the population median. These findings indicate that rainbow trout have variable amounts of plasma ladderlectin capable of binding to the surfaces of several relevant bacterial targets.



Identification of highly freeze-resistant winter flounder (*Pleuronectes americanus*)

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Winter flounder can survive water temperatures reaching as low as -1.9°C by producing antifreeze proteins (AFPs) that bind to the surface of ice crystals and inhibit ice growth. AFP production differs among populations of winter flounder along the east coast of North America. Variations in AFP levels between fish from different locations were previously shown to be genetic rather than environmental in origin. Maximal winter AFP activity in flounder plasma appears to be directly proportional to gene copy number and small-scale semi-quantitative studies have suggested that copy numbers differ widely among populations. Current work aims to accurately determine the AFP gene dosage in representative samples of fish from populations extending along the eastern Canadian coastline and to confirm that the dosage is directly predictive of plasma AFP levels. Quantitative PCR (qPCR) assays are being designed and validated for this purpose. We have designed primers specific for the genes encoding the major serum AFPs of winter flounder in order to accurately quantify AFP gene copy number by qPCR. Our goal is to develop the means of identifying the most freeze-resistant winter flounder, a promising species for aquaculture.

Re-seeding of soft-shell clam (*Mya arenaria*) spat along the Eastern Shore, Nova Scotia.

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Harvesting soft-shell clams (*Mya arenaria*) from Nova Scotia's vast mud flats has been an essential source of income for many inhabitants of these rural coastal areas. Over the past decade there has been a steady decline in the population of soft-shell clams. It is essential to determine attributing factors to amplify populations for future years. Regional population assessments were conducted in Eastern Chezzetcook and Clam Harbour, Nova Scotia in order to determine current clam status. Spat growth and percent viability was examined when placed under two different sediment types; a soft substrate (0.6% by wt) and a hard substrate (1.3% by wt). The influence of a predator net on these substrates was also examined. Viability was greater when seeded in a soft substrate $86.7 \pm 1.3\%$ versus a hard substrate $70.0 \pm 2.2\%$. The impact of a predator net resulted in a low ($p < 0.05$) percent viability for both substrates. The use of a predator net on a hard substrate was $16.6 \pm 1.22\%$ and $23.3 \pm 0.89\%$ on a soft substrate. Growth was not significantly ($p > 0.05$) influenced by soil substrate. Growth in a hard substrate was $0.4 \pm 0.11\text{cm}$ and 0.3 ± 0.07 with a predator net; 0.378 ± 0.15 in a soft substrate and 0.3 ± 0.10 with a predator net.



Short-term dynamics of sea scallops and their predators following large-scale seeding in the southern Gulf of St. Lawrence, Eastern Canada

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Commercial-scale seeding operation of sea scallops (*Placopecten magellanicus*) have been done in Magdalen Islands, (Québec, Canada) since 2000. Previous observation indicate that seeded scallops are subjected to high predation pressure shortly after seeding. A 3-year study initiated in 2003 was undertaken to investigate the spatial and temporal dynamics of this predation. Densities of scallops and predators were estimated using video sequences collected from a camera mounted on a large mobile sleigh towed by the boat. Predation potential was studied with tethered scallops (25-35 mm) on metal frames deployed to the sea bed and removed after 24-48 hours. Results showed that predator densities were not affected by the seeding in 2003 and 2004, since no particular change was detected on the seeded area compared to control sites. On a seasonal basis, the density and size structure of each predator species were stable in 2003. However, predator densities tended to be higher and more variable in July 2004. Predation potential showed spatial and temporal fluctuations on the seeded and control sites in 2003 and 2004. Losses associated with sea stars and crabs were estimated at 15% and 4%, respectively. A behavioural study indicated that sea star predation was about 15 times higher on tethered than untethered scallops; so, corrected scallop loss related to sea stars was estimated at 1%. This project collects much information on the dynamics of predators and scallops shortly after large-scale seeding operations.

Mercenaria mercenaria upon the bottom, who has the best thermal adaptation potential?

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The hard clam *Mercenaria mercenaria* is distributed from New-Brunswick (CA) to Florida (USA), and therefore lives in a wide range of temperatures. At the limit of the northern distribution, a previous study on overwintering showed that elevated mortalities of the selectively bred hard clam (var. *notata*) coincide with a reduced remodelling of lipid compared to that of wild animals. To validate if this phenomenon also occurs in adults, individuals from Tabusintac bay (NB), Bouctouche bay (NB), Tatamagouche bay (NB), St. Mary's bay (NS) and the selectively bred variety were set in low intertidal zone of the Bouctouche bay (NB). The lipid contents of digestive gland and gills are determined each month from August to December 2006. With this experimental design, a difference in lipid composition is expected between the wild stocks, which live in different temperature gradients, and the selectively bred hard clam.



Harpacticoid copepods in a cold marine mesocosm: production in sand filters and diel migrations in the water column

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Previous research showed that harpacticoid copepods were abundant (up to 40 g/m²) in the rapid sand filters of the Marine St. Lawrence mesocosm at the Montreal Biodome, and that they were found at all times in the mesocosm water column. The current study's objective was to estimate their production in the filters and their diel migrations in the water column. Samples (800 L) of the water supplies entering and leaving the filters were filtered over tiered sieves, and copepodites and adults were counted. Four copepod species were found: *Amonardia normani* (79%), *Pseudonychocampus proximus* (20%), *Tisbe furcata* and *Mesochra pygmaea* (1%). The 300 µm, 150 µm and 63 µm sieves retained 77%, 21.5% and 1.5% of the specimens, respectively. Daily production of copepods was 220,000 ind./m² in summer and 133,000 ind./m² in winter. These values are 100 to 917 times greater than reported rates in nature. Copepod density in the water column reached 401 ind./m³. Diel vertical migrations were not observed during the regular operation of the mesocosm but did occur within five days after feeding and cleaning dives were suspended. This study therefore showed that water circulation is efficient at keeping harpacticoid copepods suspended in the mesocosm water column.

Growth, body morphology and muscle metabolism patterns in two newly-hatched salmonids species (*S. alpinus* and *O. mykiss*): effects of water velocity.

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Increased growth rate at higher rearing velocities is a common observation in salmonids. The improvement in swimming performance (max. sustainable speed, rates of recovery, endurance) remains poorly documented. We propose to use indicators of enhanced swimming performance and muscular growth of newly-hatched Arctic charr and Rainbow trout, two species with different degree of polymorphism. The impact of water velocity on body morphology, growth and temporal changes in white muscle metabolic capacities (citrate synthase, lactate dehydrogenase and nucleoside diphosphokinase) were measured. Newly-hatched fish were reared for a duration of 100 days at four water velocity: A = 3.2 cm s⁻¹, B = 1.6 cm s⁻¹, C = 0.8 cm s⁻¹ and D=0.4 cm s⁻¹. At the end of the growth trial on Arctic charr, the velocity treatments were reversed i.e. high velocity (HV) fish were transferred to the low velocity (LV) rearing units and vice-versa and adjustment in enzyme activity level of LDH, CS and NDPK monitored for a period of 67 days. In the case of Rainbow trout, the white muscle enzymatic adjustments monitoring strictly covered the first 80 days post-hatch. Results show that the HV treatment (A) had a more pronounced impact on growth rate, body morphological traits compared with the groups exposed to lower water velocity (treatments B, C and D).



Lipid profile transfer from frozen-concentrated marine microalgae to rotifers (*Brachionus plicatilis*)

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There is a growing interest in preserving microalgal preparations so that constant properties can be maintained over a long period. The aim is to ensure sufficient delivery of essential fatty acids (and other key nutrients) to mollusc and crustacean larvae and to zooplankton used as live prey in the first feeding of fish larvae. The rotifer *Brachionus plicatilis* has to be enriched with polyunsaturated fatty acids (PUFAs) prior to fish feeding. Four microalgal species (T-ISO, CHGRA, MONO, *Nannochloropsis* sp.) have been used either as fresh culture or in the frozen-concentrated form to enrich rotifers. Overall, the fatty acid composition of rotifers showed similar relative levels of fatty acids when fed the frozen or fresh microalgal diets. Significant linear relationships were observed for relative levels of 20:4n-6, 22:6n-3 and 20:5n-3 between *B. plicatilis* and the microalgal diets. The fatty acid that was the most assimilated by rotifers was 20:4n-6: the content found in rotifers reached half the level measured in the microalgal diets. Our results indicate that both the fresh and frozen-concentrated forms of the four microalgal species can be used to enrich rotifers in PUFAs. Further experiments should be conducted to test if assimilation differs when rotifers are enriched with mono- or multispecific microalgal preparations.

The influence of current velocity on blue mussel (*Mytilus edulis*) settlement in Back Bay and Bliss Harbour, New Brunswick

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The influence of the settlement of blue mussel larvae, *Mytilus edulis*, intended for commercial harvest, is of particular significance to the development of the Integrated Multi-Trophic Aquaculture (IMTA) industry in the Bay of Fundy region. Spatial and temporal comparisons of the mean settlement density, and mean shell area of mussel larvae, were made between three regions of varying current velocities within Back Bay and Bliss Harbour, in the Bay of Fundy. Fifteen polypropylene lines, with six collector panels attached, were deployed over a four week period. Three of the six panels were deployed for the entire four weeks duration, whereas the remaining panels were collected and replaced after two weeks duration. Mean settlement densities varied with respect to the collection period, current zone and duration, however, medium and slow current velocity zones exhibited the greatest numbers throughout. Total settlement of the 2 two-week duration panels for each current velocity zone, did not equal that of the four-week duration panels, suggestive of a synergistic effect of settled mussels on future settlers, or perhaps improved biofilm development. As interest in the IMTA mussel industry continues to grow, these data have implications for site locations selected by future cultivators.



Survey of Giant scallop (*Placopecten magellanicus*) spat collecting losses in Gaspé Bay, Quebec

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A recent survey of giant scallop spat collectors in the Gaspésie and the Magdalene Islands shows that 70-90 % of spat is lost before the usual recuperation time at the end of summer. In order for the producer to adopt an effective operating strategy of pre-growth, he needs to know the seasonal evolution of spat quantity and size. In order to do so, divers sampled three long lines which had been immersed within three weeks in late autumn of 2004. Five collectors were retrieved every 2 weeks from June to November in 2005 and during three sampling periods in 2006. The recuperated collectors were washed and sorted in the following days to determine the progression of loss, spat, growth and the evolution of marine biofouling. This also permits the determination of the best time for commercial sorting. The survey shows that losses increased progressively from June to the end of July and then stabilized until early November during the first season survey. In June 2006, at the start of the second season survey, giant scallop spat quantity shows a drop after overwintering. The quantity stayed about the same during the three sampling periods (2 in June and 1 in August). No growth occurred in 2006. No new spat recruitment during the second autumn collecting season was identified.

Expression of recombinant Atlantic salmon (*Salmo salar*) serum C-type lectin in *E. coli* and *Drosophila* cells

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A C-type lectin from Atlantic salmon serum binds mannose and related sugars and also binds to the surface of *Aeromonas salmonicida*. To obtain large quantities of protein for study, we expressed recombinant lectin in *E. coli* and fruit fly (*Drosophila melanogaster*) S2 cells. Lectin preparations from these sources were compared to their natural counterpart purified from salmon serum. *E.coli* expression of the salmon lectin fused with a hexahistidine tag gave limited quantities of functional protein. Thus, to produce sufficient protein for structural analyses and bacterial binding studies, we expressed the lectin with a hexahistidine tag, under the control of the *Drosophila* methallothionein gene promoter in S2 cells. Upon induction of stable cell lines, recombinant salmon lectin was secreted into the cell culture medium and purified using Ni²⁺-chelate affinity chromatography. Future research will concentrate on identifying the ligand from the surface of *A. salmonicida*. Understanding the molecular mechanism of pathogen detection by the salmon C-type lectin may lead to new means of preventing disease in salmonids and other fish species.



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