# 30th Anniversary Awards

Bulletin of the Aquaculture
Association of Canada (112-2) (2014)

# Bulletin
## de l'Association aquacole du Canada
### 112-2 (2014)

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ISSN 0840-5417

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# Bulletin
## of the Aquaculture Association of Canada
### 112-2 (2014)

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ISSN 0840-5417

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# 30th Anniversary Awards Bulletin

Joy Wade, Editor

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# Introduction

In recognition of the 30th Anniversary of the Aquaculture Association of Canada, a Bulletin has been produced which acknowledges the different awards presented this year. Normally, we award the Lifetime Achievement Award in alternate years with the Research Award of Excellence, this year because of the 30th Anniversary we awarded both. As in previous years, we acknowledged the efforts of students with Best Student Oral Presentation and Best Student Poster awards as well as two scholarship awards. In addition, in celebration of the 30th Anniversary, we held an essay contest for both undergraduate and graduate students, for which cash prizes were awarded.

The Awards Committee would also like to take this time to formally thank all the members of the Association who participate in judging student posters and presentations. Each year we rely on your participation and it is gratefully appreciated.

**Joy Wade**

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# Lifetime Achievement Award

This award recognizes individuals for their outstanding contribution to the Association and to the aquaculture sector in Canada.

### Cyr Couturier

Armed with a degree in Marine Biology in the late 1970s, Cyr became interested in applying his education to help solve some of the emerging issues facing the world in terms of food security; capture fisheries were under increasing human and environmental pressure and aquaculture seemed like a good option to focus upon. Cyr completed his graduate studies in Marine Biology from Dalhousie University in 1986.

He has 35 years' experience in applied research, project development, teaching, and extension services in the aquaculture and fisheries sectors. He is currently Chair of aquaculture programs at Memorial University, with programs ranging from junior high to on-farm extension courses to post-graduate professional and research degrees. He is a research scientist with the aquaculture section of the Marine Institute of Memorial University. His areas of research span a range of topics, including enhanced farm production, environmental management and aquaculture interactions.

Cyr held adjunct faculty position at the Bermuda Biological Station for Research for several years teaching field courses in marine resource management and aquaculture. He has worked in 18 countries around the world in development, trade missions, and extension and technology transfer / science exchange programs. All of the projects in those countries focus on aquaculture, food security, and sustainable development. Recent efforts in sub-Saharan Africa and South East Asia focus on strategies for adapting fish farming to climate change.

Cyr has had a dozen graduates complete their theses at the Masters and PhD levels. He has mentored about 200 graduate diploma students in aquaculture, over 200 junior and high school students in aquaculture programs and hundreds of fish and shellfish farmers around the globe. Many of the students have gone on to leadership positions in academia, government and industry, and for Cyr this is the most rewarding part – seeing the students succeed in the world of aquaculture.

Cyr participates fully in a range of academic, industry and professional organizations devoted to sustainable aquaculture and community development. He has helped organize dozens of workshops, several national conferences, and numerous sessions at national and international meetings, all with an aquaculture focus. He has been a Director with the NAIA since 1996, an Executive Director for three terms, and is currently a second term President. He is President of the Newfoundland Francophone Development Association (since 2009). He was a Board member of the AAC for nearly two decades (from 1990 to 2010) including three terms as President; he was the first student ever elected to that Board. He is a Director and Executive member of the Canadian Agricultural Human Resource Sector Council (since 2007). He is a Director and Executive Officer for CAIA for a dozen years since 1996. In the 1980s he held executive positions on the Aquaculture Association of Nova Scotia Board.

Cyr has been honoured as the recipient of the Aquaculturist of the Year 2008 for the NAIA, and in 2013 he was inducted into the Science Atlantic Hall of Fame for his contributions to the Aquaculture and Fisheries Committee.

He is a technical advisor to several federal government departments and agencies on sustainable aquaculture issues, including Environment, Fisheries and Oceans, Employment and Skills Development, ACOA, CFIA and many others. He is an SQF Expert, experienced in HACCP and Quality Management Programs, as well as a member of standard development technical committees (e.g., BAP Mussel Standard). He is a member of several grant selection committees funding pure and applied, innovative science in aquaculture and allied sectors. He has published close to 100 technical, industrial, peer-reviewed, and science and policy commentary articles, in English, French and Norwegian. He is a frequent invited speaker and technical expert (in both French and English) at regional, national, and international symposia on aquaculture and fisheries related topics.

Cyr is looking forward to the second half of his career in sustainable aquaculture, and is grateful for the support, collaboration, friendship and patience of his colleagues, students, industry partners, and acquaintances on this journey called sustainable aquaculture

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Armé d'un diplôme en biologie marine à la fin des années 1970, Cyr s'est intéressé à l'application de son éducation pour aider à résoudre certains des défis émergents dans le monde en termes de sécurité alimentaire; les pêches traditionnelles et l’environnement étaient sous une forte pression de la population humaine croissante et l'aquaculture semblait être une bonne option pour résoudre ces défis. Cyr a complété ses études supérieures en biologie marine à l’université Dalhousie en 1986.

Il a 35 ans d'expérience dans la recherche appliquée, développement de projets, l'enseignement et les services de vulgarisation dans les secteurs de l'aquaculture et de la pêche. Il est actuellement président des programmes en aquaculture de l'Université Memorial, avec des programmes allant de la ferme jusqu'aux degrés de recherche professionnelle et post-universitaire. Il est chercheur scientifique en aquaculture à l'Institut maritime de l'Université Memorial. Ses domaines de recherche couvrent un large éventail de sujets, notamment l'amélioration de la production aquacole, la gestion de l'environnement et les interactions de l'aquaculture.

Cyr a tenu un poste de professeur adjoint à la station de recherche biologique des Bermudes pendant plusieurs années ou il a enseigné des cours sur la gestion des ressources marines et en aquaculture. Il a travaillé dans 18 pays à travers le monde dans le développement, des missions commerciales, des programmes d'échange et de transfert de la science et de la technologie. Tous les projets dans ces pays se concentrent sur l'aquaculture, la sécurité alimentaire et le développement durable. Les efforts récents de l'Afrique au sud du Sahara et en Asie du Sud-Est s'accentuent sur les stratégies d'adaptation de la pisciculture au changement climatique.

Cyr a dirigé une douzaine d'étudiant(e)s à la maîtrise et au doctorat. Il a encadré environ 200 étudiant(e)s au diplôme d'études supérieures en aquaculture, plus de 200 jeunes et lycéens dans les programmes en aquaculture et des centaines de producteurs aquacoles à travers le monde entier. Beaucoup de ces étudiant(e)s ont accédé à des postes de direction dans le milieu universitaire, du gouvernement et de l'industrie, et pour Cyr c'est la partie la plus gratifiante - voir les ancien(ne)s élèves réussir dans le domaine de l'aquaculture.

Cyr participe pleinement à des comités universitaires, de l'industrie et des organisations professionnelles consacrées à l'aquaculture durable et le développement communautaire. Il a aidé à organiser des dizaines d'ateliers, plusieurs conférences nationales et de nombreuses séances à des réunions nationales et internationales, le tout portant sur l'aquaculture. Il a été directeur de la NAIA depuis 1996, un directeur exécutif pour trois termes, et est actuellement sur son deuxième mandat comme président. Il est président du Réseau de développement économique de Terre-Neuve (depuis 2009). Il a été membre du Conseil de l'AAC depuis près de deux décennies (1990-2010), y compris trois mandats en tant que président; il fut le premier étudiant à être élu à ce conseil. Il est administrateur et membre du comité exécutif du Conseil canadien des ressources humaines du secteur agricole (depuis 2007). Il est administrateur et dirigeant exécutif de l'AICA pour une dizaine d'années depuis 1996. Dans les années 1980, il a occupé des postes de direction sur l'Association aquacole de la Nouvelle-Écosse.

Cyr a été honoré en tant qu'Aquaculteur de l'année 2008 pour la NAIA, et en 2013 il a été intronisé au Temple de la renommée de Science Atlantique pour ses contributions au Comité de l'aquaculture et de la pêche.

Il est conseiller technique à plusieurs ministères et agences fédéraux sur des questions d'aquaculture durable, y compris Environnement, Pêches et des Océans, de l'Emploi et du Développement des compétences, l'APECA, l'ACIA et beaucoup d'autres. Il est un expert SQF, connait le système HACCP et les programmes de gestion de la qualité, ainsi que membre des comités techniques de développement des normes (par exemple, norme BAP pour les moules). Il est membre de plusieurs comités de sélection des subventions de financement, pour l'innovation scientifique pure et appliquée en aquaculture et des secteurs connexes. Il a publié près de 100 articles techniques, de vulgarisation, des articles de revus par des pairs, en science et la politique, en anglais, français et norvégien. Il est fréquemment invité comme conférencier et expert technique (en français et en anglais) à des colloques régionaux, national et international sur l'aquaculture.

Cyr se réjouit de la seconde moitié de sa carrière dans l'aquaculture durable, et est reconnaissant pour le soutien, la collaboration, l'amitié et la patience de ses collègues, des étudiants, des partenaires de l'industrie et des connaissances sur ce « voyage » qu'on appelle l'aquaculture durable.

## Santosh Lall

Dr. Lall is an outstanding scientist, mentor and leader in the field of nutrition. Dr. Lall completed his BSc in Agriculture in 1965 from Allahabad University in India. He completed an MSc in Animal Science in 1969 and a PhD in Nutrition in 1973 from the University of Guelph and has remained in Canada ever since. In 1974, he accepted a position in Halifax as a Research Scientist with DFOs Aquaculture Division and remained there until 1994. From 1994 to 1996 he was the Head of the Fish Health and Nutrition section at DFO and then became a Senior Research Officer and ultimately Principal Research Officer at the NRC Institute for Biosciences. Santosh retired in 2013 but remains an Adjunct Professor or Honorary Research Associate in five different Atlantic Canadian University departments.

Dr. Lall is a pioneer in the aquaculture industry and has contributed significantly to the science leading to the formulation of effective, efficient diets of marine invertebrates and vertebrates for the aquaculture industry. He has dedicated his career to the understanding of the nutritional requirements of marine species and the adoption of new, innovative feed ingredients to boost the development of the industry. Santosh has played a central role in the development and maturation of public and private aquaculture since the 1970s.

Not only does Santosh continue to be a source of inspiration and guidance to industry in the field of nutrition. He has provided this same guidance and inspiration to many university students and industry personnel throughout his career and continues to shape the next generation of researchers. Santosh is known for his dedication to students and their individual success. He has advised countless undergraduate, graduate and post doc fellows and has influenced and inspired students from around the world.

Dr. Lall's work is not only recognized within Canada but also internationally. He has been involved with the publication of NRC's Nutrient Requirements of Fish and has long participated in the International Symposium of Fish Nutrition and Feeding. He has contributed to Halver's first edition of the Fish Nutrition text book in 1979 and has contributed to every edition since. Over his 40 year career, he has co-authored 7 book chapters and over 100 peer-reviewed journal publications.

He has been awarded the Minister's Merit Award for Technology Transfer by DFO in 1993, the Research Award of Excellence by AAC in 2000 and the Governor General's Queen Elizabeth Diamond Jubilee Medal for his significant contributions to Canadian society in 2013.

Santosh Lall has been awarded the Lifetime Achievement Award from the Aquaculture Association of Canada for both his dedication to the science of aquaculture nutrition research as well as the lifetime of support and inspiration he has provided for those who work in the industry.

# Research Award of Excellence

This award recognizes high quality, innovative and current research that has had a significant impact on the aquaculture industry in Canada.

### Fred Page

Dr. Page was born in Saint John New Brunswick and attended Saint John High School. From an early age he has been interested in the multi-disciplinary aspects of marine biology and oceanography, especially in physical-biological interactions and the applications and implications to human activities. He received a Bachelor of Science (Hons) in Marine Biology from the University of New Brunswick in Saint John, a Masters of Science in Biology from the University of New Brunswick and a Doctor of Philosophy in Oceanography from Dalhousie University. Dr. Page's initial foray into aquaculture research included some limited experimentation with the outgrowing of Bay Scallops and the development of software for tracking and predicting feed utilization and growth of trout reared in a land based system. As a Fisheries and Oceans Canada research scientist he has worked closely with industry representatives, government policy makers and regulators as well as university colleagues and has developed and led a research team whose aquaculture research has focused on relating physical and chemical aspects of the marine environment to applied aspects of aquaculture production and regulation. His work has emphasized the acquisition of in situ measurements of temperatures, salinities and dissolved oxygen, sediment sulphide, water currents, waves, the transport and dilution of suspended substances and the development of numerical analyses and predictive models. He has conducted research activity related to applied issues such as the carrying capacity of mussel and finfish culture, oxygen depletion by salmon farms, spread of ISA and the development of aquaculture bay management areas, transport and deposition of organics released from finfish farms, spatial and temporal variation in sediment sulphide, design of aquaculture environmental impact monitoring programs, and the transport and dispersal of sea lice therapeutants released from net pens and well boats. He has been the Director of the DFO's Center of Expertise on Integrated Aquaculture Science, an official member of Canadian aquaculture science delegations to Spain and Chile, a member of a Canadian delegation to a Pacific Rim aquaculture conference, a contributor to several DFO advisory documents relating to aquaculture, a member of various aquaculture regulatory support committees, an adjunct professor at several universities, a recipient of distinction awards for contributions to sea lice integrated pest management research and team work, partnership and cooperation, a member of the United Nations team on the status of the world's oceans, and an invited scientific reviewer of the New Zealand NIWA aquaculture environmental interactions program. In the future Dr. Page hopes to continue researching along these lines with an emphasis on developing better predictive models and decision support tools of use to aquaculture regulation and development.

# Undergraduate Student Essays

Students were asked to answer the following essay topic: How has the aquaculture industry or aquaculture research changed over the past 30 years in Canada?

## Rebecca Blank (Winner)

Dalhousie University

**Swimming Into the 21st Century: The Recent Evolution of Canada's Aquaculture Industry**

Aquaculture is the rearing and farming of fish, shellfish, and some aquatic plants in a controlled environment (Encyclopaedia Britannica). Also known as fish culture or mariculture, aquaculture supplements the natural supply and is practiced worldwide; once the farmed aquatic life has matured, they are processed and transported to markets for profit (Encyclopaedia Britannica). Surrounded by three oceans and home to the Great Lakes, aquaculture is well-suited to Canada. We have the longest coastline, the most extensive freshwater system, and the greatest range of tides in the world (Canadian Aquaculture Industry Alliance). Over the past thirty years, the aquaculture industry has played an important role in the ongoing evolution of our nation's economy, ecology, and society. This paper discusses some key changes to the Canadian aquaculture industry from the mid-1980s to present.

Though this paper focuses on changes in the aquaculture industry in recent decades, it is important to note that First Nations of Canada were among the first aquaculturists, transferring different species of fish between rivers (Suprenant, 2010). Commercial Canadian aquaculture commenced in the 1950s, but it was not until the mid-1980s that the aquaculture industry really exploded (Fisheries and Oceans Canada, Economic and Socio-Economic Impact of Aquaculture in Canada). Salmon in British Columbia and mussels in Prince Edward Island were among the first big commercial aquaculture enterprises (Suprenant, 2010).

Statistics show that the tonnage of farmed aquatic life produced has increased dramatically since the 1980s. The Canadian Aquaculture Industry Alliance reports that aquaculture production jumped from 10,488 tonnes in 1986, with an output value of $35 million, to 171,829 tonnes in 2006, with an output value of over $912 million, marking an exponential growth rate. In 2006, farmed salmon was the most important contributor to Canada's aquaculture industry, with 118,058 tonnes produced at a value of $748 million. In eastern Canada in particular, the production of aquaculture increased from approximately 6,000 tonnes to 68,000 tonnes between 1986 and 2008, generating $339 million in revenue (Suprenant, 2010).

According to Fisheries and Oceans Canada, production of aquaculture over the past twenty years has increased four-fold (Aquaculture Statistics, Facts and Figures) and the value between 1996 to 2012 almost tripled (Aquaculture in Canada 2012: A Report on Aquaculture Sustainability). In 2010, the output value reached an all-time high of $926,504,000. Over the past five years, however, Statistics Canada shows that aquaculture production has not changed significantly. Today, aquaculture creates "about $2 billion in total economic activity, over $1 billion in GDP and about half a billion in labour income" (Fisheries and Oceans Canada, Aquaculture in Canada 2012: A Report on Aquaculture Sustainability). Occurring in all Canadian provinces and in Yukon, the aquaculture industry provides 14,500 full-time jobs to Canadians (Fisheries and Oceans Canada, Aquaculture Statistics, Facts and Figures).

As the industry continues to grow, aquaculturists, scientists, and consumers have become increasingly aware of the environmental impact of aquacultural practices and the threats that aquaculture poses to natural ecosystems. Today, there is a push towards greener, more environmentally responsible, eco-friendly aquaculture practices. This led Fisheries and Oceans Canada to develop a program for sustainable aquaculture in 2008 (Suprenant, 2010). Studies have shown linkages between the aquaculture industry and environmental issues, such as "nutrient enrichment, habitat alteration, and damage to wild fish populations" (Podemski & Blanchfield citing Gross, 1998). At present, there are ongoing scientific studies into the generation of fish farm waste matter (that is, pollution and contamination from the waste of cultured fish) and the interaction between farmed and wild aquatic life. Additionally, changes in the climate, such as rising water temperatures and sea levels and increased storm activity, are also major concerns for the aquaculture industry, which the Intergovernmental Panel on Climate Change reported on in 2008.

A major movement affecting the aquaculture industry is a demand from consumers and environmental stakeholders for sustainability. The Aquaculture Sustainability Reporting Initiative—composed of various ministries, governmental agencies and departments, associations, and other groups from across the country—has recently outlined six key sustainability concerns that the aquaculture sector must address, as follows: Ecosystem Health, Animal Health and Welfare, Safe and Healthy Products, Resource Use, Social Responsibility, and Economic Viability. In May 2012, the province of Nova Scotia put forward a new aquaculture strategy and action plan that focuses on the importance of sustainability: It provides guidelines and policies for aquaculture operators, and it also calls on the government to ensure that fish farming is done responsibly with regulatory safeguards in place.

Another change in the aquaculture industry is consumer demand for organic aquaculture. The Canadian Organic Aquaculture Standard was released in 2012, which allows consumers to purchase certified organic farmed products. This set of standards prohibits farmers from using antibiotics, herbicides, and genetically modified organisms in their aquaculture practices and restricts the use of parasiticides or pesticides. These standards seek to minimize waste in several ways: by setting requirements for stocking density rates and cleaning procedures, and by limiting the types of feed source and cleaning materials that can be used by aquaculturists. At this point, the Canadian Organic Aquaculture Standard is not yet regulated by the government.

Furthermore, technological advances over the past few decades have increased the possibilities for environmental monitoring of aquaculture sites. Today, monitoring farming activities may involve GIS (Geographical Information System) technologies, computer modelling, video recording, and other cutting edge technologies.

The aquaculture industry in Canada will see more growth in the future. According to Fisheries and Oceans Canada, it is possible that aquaculture production may double by 2020, potentially reaching—or even exceeding—308,000 tonnes (Suprenant, 2010). With this projected growth in mind, it will be essential for the Canadian aquaculture industry to respond to the evolving demands of consumers and stakeholders, especially in regard to sustainability and healthy, eco-friendly practices and products.

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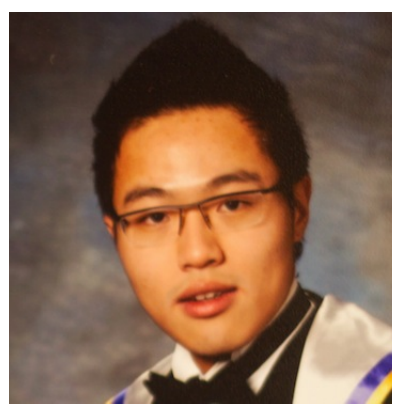
# Yangfan Zhang

Dalhousie University

**The Change in Aquaculture Research: Diversity and Environmental Awareness**

Canadian aquaculture has expanded over the last 30 years. Research funding continuously channels from the government and aquaculture companies into the industry for optimal development. As a recent trend, aquaculture research switches from intensive salmonid studies to candidate aquaculture species and environmental issues of marine open net pens, but salmonid aquaculture is still the dominant aspect of research, and industry production within Canada.

Canadian aquaculture production increased from 10,488 to 144,684 tonnes from 1986 to 2008, which created $913 million peak revenue in 2006 (Surprenant, 2013). The salmonid aquaculture, especially Atlantic salmon is most successful and most contributed to. It is approximately 90% of overall revenue, because of suitable growing environments (thermal profile), excellent growth of fish, strong market demand, and absence of fishery competition (Duston, 2013). In Nova Scotia, Atlantic salmon culture started in Arichat bay in 1972. Unfortunately, all Atlantic salmon died because of a storm with lethal winter temperatures. In 1973, Atlantic salmon farming started in Poly Cove, Nova Scotia, however, harmful algae bloomed as a result of the heavy loss. Due to the unsuitable environmental conditions in most of the Nova Scotia coastal area, Atlantic salmon farming is restricted in parts of St. Margaret's Bay, the Annapolis Basin, the Bras d'Or Lakes, and Shelburne Harbour (Government of Nova Scotia, 2007). In the late 1970`s, the Atlantic salmon culture broke through the bottle neck in New Brunswick, Arne Sutterlin, Dick Saunders, and Gene Henderson, from St. Andrews Biological Station conducted a trial on Deer Island. Deer Island is mainly a site salmon grow from in New Brunswick. The huge tides in the Bay of Fundy mix the surface ocean water and bottom ocean water which can keep the water temperature more than 1 degree Celsius the winter and maintain survival of Atlantic salmon(Duston, 2013). There was a great expansion of Atlantic salmon farming in the 1980s and 1990s in New Brunswick, the pick price was $6.35 in 1987. However, a furunculosis outbreak had spread rapidly in New Brunswick in the summer of 2003, because the sea cages were crowded in a relatively small area. After that, the salmonid production stopped expansion and kept approximately 24,000 tonnes in New Brunswick. In the 1970s, the Pacific salmon culture began in the Strait of Georgia, British Columbia. However, it failed at the beginning, because of the algal blooms and low oxygen in the poor tidal exchange area. Then, the Atlantic salmon farming began on Vancouver Island and grew to the most economically successful Atlantic salmon farming operation in Canada with 85,000 tonnes of production in 2011, which is over two thirds of finfish production in Canada. In 2007, the farmed salmon production (75,000 tones) had surpassed ranched salmon production (70,000 tones) in British Columbia, Canada (Duston, 2013).

With 30 years of development, over 90% of production is Atlantic salmon. Over-reliance on one species is too risky, therefore, diversification is necessary (Duston, 2013). Sturgeon, Atlantic haddock, Atlantic cod, Atlantic halibut, and striped bass have been studied and some of them have been tried for commercial production. However, none of them have achieved significant success as that of Atlantic salmon. A sturgeon farm in New Brunswick went bankrupt in August 2010, and then got a new owner in 2012, but whether or not it makes money is questionable. Atlantic haddock and cod got government funding to attempt to develop new aquaculture species. Atlantic haddock wild stock recovered, then the farmed haddock did not have a price advantage to compete with the wild stock. An Atlantic cod broodstock development project obtained $18.1 million in funding, but the funding was cut in 2010. The difficulty of cod is the early sexual maturation before market size, and susceptibility to 'Nodavirus' (Duston, 2013). Atlantic halibut and striped bass have the potential to be commercially important aquaculture species (Ahlstrom et al., 1984; Clark et al. 2005). Both are at the initial domestication stage in Canada. Atlantic halibut aquaculture began in the 1990s' in Canada (Rogers, 2002). Wild broodstock began to spawn in 2001, however, Fl broodstock started spawning in 2008 in Scotian Halibut Ltd. The company sells 5 gram juveniles to Scotland and Norway, because of the strong market demand in Europe and weak domestic market demand. The earliest striped bass domestic experiment started in the St Andrews Biological Station from 1988 to 1997. Huntsman Marine Science Centre began a research program in 1989 and subsequently produced striped bass eggs for aquaculture production. Until 1999, small commercial operations started in Atlantic Canada and Quebec however; business failed until 1999. These facilities used Shubenacadie River stock. Nova Scotia Agricultural College (now Dalhousie University Faculty of Agriculture) became involved in a research program in the early 1990s' until now (Bradford et al. 1999). The 3kg striped bass have a market value of $4.50/pound with market potential; however, few striped bass commercial production was conducted (Duston, 2013).

The economy of the rural coastal zone is benefitted by the aquaculture industry development (Parliament of Canada, 2013). However, the environmental concern of the open pen sea cage is that it slows down aquaculture expansion. Especially, the NIMBY (Not In My Backyard) in Nova Scotia, which is a local environmental group that opposes aquaculture, especially the open net pens. In the Parliament of Canada, there is a debate about the feasibility, advantages, and disadvantages of closed containment. Closed containment aims to rear up finfish in the ocean and eliminate the negative environmental impacts, such the impacts of wastes on the ocean ground sediment. The research of integrated multi trophic aquaculture is another potential solution for the waste from open net pens. Cooke aquaculture has built an integrated multi trophic site to demonstrate the feasibility, however, the amount of waste that can be absorbed is critical. Natural Sciences and the Engineering Research Council of Canada, Dalhousie University, and Cooke Aquaculture cooperate to issue Cooke Industrial Research Chair for sustainable aquaculture, including disease and waste management of salmon in net pens, and the interaction of salmon aquaculture, and lobster fishery. From my opinion, this research project has the potential to figure out the truth of how much positive or negative impact that open net pen sea cages affect the ecosystem and maintain a correct direction for aquaculture development in Canada.

With the further development of aquaculture, the more successful story of diversified species will be up to date due to more research on the candidate aquaculture species. The flourishing Atlantic salmon industry will pay more attention to sustainability. Hopefully, aquaculture is still a young and fast developing industry in Canada, which can provide healthy protein for Canadians at lower prices. Farming can be beyond the land by aquaculture, but it needs more attention from the public and government to aid the development in the initial stages and cultivation of the market demands.

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# Graduate Student Essays

Students were asked to answer the following essay topic: Define sustainable aquaculture in a Canadian context and describe what is required to achieve this goal.


## **Stacy Murray** (Winner)

University of New Brunswick, Saint John


**Define sustainable aquaculture in a Canadian context and describe what is required to achieve this goal.**

Aquaculture is essential and Canada has the potential to be a world leader in production and sustainability. As the world population increases and wild fisheries continue to collapse the need for sustainable aquaculture is ever present. The Canadian aquaculture industry has seen a huge increase in production from its humble beginnings in the 1970's. This development exceeded the required research which caused some negative perceptions of aquaculture and hindered its acceptability and its ability to be sustainable. One definition of sustainability is the capacity to endure or to be used without being devastated. In Canada this is not explicit to our beautiful natural resources but also to our jobs and well-being. To increase the development of aquaculture in a sustainable way there are aspects that require consideration: environmental, societal and economical. By addressing these three concerns Canada can be a leader in world aquaculture.

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

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

Societal sustainability in aquaculture can be obtained with improving the public perception of aquaculture. Most farms are located in rural coastal communities and can greatly improve the quality of life for these individuals by providing local food resources, jobs and community infrastructure. This is particularly important where wild fisheries are no longer able to sustain these communities. Acceptance of aquaculture products will increase the quantity of products being sold allowing farmers to increase profits. This will also be an incentive for the development of new farms. The acceptance of aquaculture products requires science based education. The development of on-land grow-out farms will also increase the acceptance of aquaculture by decreasing multi-use conflicts of ocean sites. Many of the ideal ocean sites for fish farms are also used for fisheries, recreational use or can be eye-sores for residents. Aquaculture needs to not only be attractive to farmers, but also to Canadian residents, consumers and stakeholders.

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

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


## Michele Patterson

University of Victoria


**Define sustainable aquaculture in a Canadian context and describe what is required to achieve this goal**

Sustainable aquaculture in Canada is aquaculture which: 1) places a priority on learning, 2) advances social, economic and ecological wellbeing, and 3) reflects a “global sense of place” in which operations in local communities are framed within a wider lens. Achieving the promise of sustainable aquaculture in Canada requires a passionate commitment to individual and community wellbeing in the context of a complex, global, wild and farmed seafood economy.

75% of the world’s seafood is now globally traded, travelling along supply chains between countries as it is harvested or farmed, then processed, packaged, marketed, and finally consumed (Deutsch et al., 2007). This new global seafood economy is also now largely demand driven, rather than supply based (Wilkinson, 2006). The role of aquaculture in the global seafood economy is also growing, with more than 50% of seafood consumption now coming from farmed fish and shellfish (FAO, 2012), and this growth, and its critical contribution to global food security is expected to continue (FAO, 2012; Delgado et al., 2003).

The world’s seafood economy has evolved from one that has been largely wild-capture, local, community adjacent, household nutrition focused, and culturally important; to a high volume, export driven, farmed seafood system (BC Stats, 2012; Khan, 2012; Subasinghe et al., 2009). These transformations in seafood have happened primarily due to flattening or declining wild capture fisheries coupled with growing demand for fish as a highly nutritious, often low calorie protein alternative; demand which existing wild fisheries can no longer meet (FAO, 2012; Delgado et al., 2009). (Indeed, the United Nations Food and Agriculture Organization (FAO) has stated that up to 87 percent of global wild capture fisheries are now considered to be either fully fished or overfished) (FAO, 2012).

Responding to multiple factors including the rising global demand for seafood (Bostock, 2010; Charles, 2010; OECD/FAO, 2012), the need to improve food security and protect livelihoods of seafood communities (Frid & Paramor, 2012; Kawarazuka & Bene, 2010) while also addressing conservation concerns can result in competing resource management public policy agendas including those that pit local against global objectives (Garcia & Rosenberg, 2010; Rice & Garcia, 2011). Further, this new global, export driven, demand-based seafood economy means that the relationship to the aquatic environment where fish species originated and the communities where they were caught or farmed is often seen as no longer relevant or consequential, impacting the social and cultural value of seafood (Fabinyi, 2011; Coulthard et al., 2009; ,17). Many coastal communities in Canada struggle with these resource related transitions brought about through globalization. Research suggests that strengthening our understanding of the social and cultural context in linked socio-ecological systems like seafood (Rice & Garcia, 2011; Coulthard et al., 2009; Kent, 1998) is necessary in order to reconcile these kinds of competing public policy agendas that challenge resource governance in Canadian settings.

Sustainable aquaculture means continued demonstration of an ability to learn within this complex 21st century environment. The sector must learn from other sectors, from good and bad experiences in communities where aquaculture operates, from ongoing research and innovation in both the natural and social sciences, and through aquaculture's ongoing experience in raising diverse species in a variety of environments.

Secondly, Canada's farmed seafood sector – both finfish and shellfish - provides much needed employment in coastal communities, while also supporting necessary services through revenue derived from trade and taxation. At the same time, aquaculture also takes place in natural marine and coastal environments, meaning the need to ensure good environmental outcomes and obtain the social license (community tolerance for new and increased development) to operate and grow. The term *wellbeing* is often used these days as a way to describe the successful integration of these social, economic and ecological objectives at both the individual and community level (Coulthard et al., 2009). Wellbeing can be defined as: "…a state of being with others, which arises where human needs are met, where one can act meaningfully to pursue ones goals, and where one can enjoy a satisfactory quality of life" (McGregor, 2004, p. 29). Sustainable aquaculture advances individual and community wellbeing by prospering in this complex global environment through its ongoing commitment to the successful integration of economic, social and ecological objectives in the places where it operates.

Finally, the concept of *place* is also an important one for Canadians, with all of our unique and diverse geographies and communities. In general, place describes a bounded space (Hubbard, 2005) which has been made meaningful in some way (Cresswell, 2004). Place-based seafood livelihoods have enabled Canada's rural coastal communities to thrive for hundreds of years, and indeed thousands of years for First Nations communities. However, the places fish are caught (if wild) or farmed are not the only places they inhabit as commodities (things people value, utilize, and exchange) (Appadurai, 1986). In a global economy, where high volume commodities like seafood now travel around the world - sometimes more than once as they move from production to consumption - the significance of place, as a bounded, meaningful space, becomes less clear.

Renewing the concept of place so that it recognizes both the important social and cultural values arising from place-based attachments but now also reflects the realities of global economic systems, is a 21st century challenge. The esteemed British geographer Doreen Massey encouraged us to think about a "global sense of place" which, in her words: "is a sense of place, an understanding of 'its character', which can only be constructed by linking that place to places beyond. A progressive sense of place would recognize that, without being threatened by it. What we need, it seems to me, is a global sense of the local, a global sense of place" (Massey, 1994, p.9).

The important role of aquaculture in Canadian coastal communities offers the sector an opportunity to show, for example, how global food security needs, including for fish protein, can be better reconciled with local community goals, avoiding the disabling dichotomy of local vs. global (Amin, 2004). Sustainable aquaculture appreciates the importance of place to coastal communities in Canada.

In summary, as an increasing component of the global seafood sector, aquaculture can and will continue to make important contributions to ensuring prosperous and stable coastal communities in Canada through ongoing learning, through supporting economic, social and ecological wellbeing, and from understanding and renewing the concept of place, within the context of a complex 21st century global seafood economy.

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# Daria Gallardi

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**Define sustainable aquaculture in a Canadian context and describe what is required to achieve this goal**

Aquaculture is the farming of aquatic organisms and it implies some form of intervention to enhance production during the rearing process. Aquaculture takes advantage of a range of ecosystem services and adverse consequences could result if the demand exceeds the environmental carrying capacity. Physical disruption, habitat loss, land-use changes, alteration in flow regimes and chemical parameters of waterways, eutrophication, escapees issues, pathogens and disease agents are some example of adverse consequences (Bunting, 2013). Pressure to define principles of responsible, ethical, low impact and sustainable aquaculture begun in the 80s. However, it is only in 1995 that those principles were enclosed by the Food and Agriculture Organization of the United Nations in the Code of Conduct for Responsible Fisheries (FAO, 1995).

Sustainable development is founded on three components, economic development, social development and environmental protection (Bunting, 2013). Sustainable practices in aquaculture allow farming fish stocks in a way that meets the present needs without however compromising the ability of future generations to meet their own needs (DFO, 2013a). In order to achieve aquaculture sustainable development a precautionary approach to avoid negative environmental impacts and protect biodiversity is needed, because it is indeed the environment that supports economic activity and sustains livelihoods and social development (Bunting, 2013).

In Canada, the key sustainability issues for aquaculture identified by the Department of Fisheries and Ocean are ecosystem health, animal health and welfare, safe and healthy products, resource use, social responsibility, and economic viability (DFO, 2013b). The actions undertaken to deal with these issues include protection of fish and fish habitat through waste management, control of introduction and transfer of fish and escapes prevention; sustainable resource use is implemented through feed management, and water and energy consumption. National regulations and international requirements for animal health aid in minimize stress, and disease risks through prevention; chain traceability is implemented to safeguard human health. Efforts to reach the best social responsibility include operating in respect of local communities and aboriginal labour and rights, and maintaining safe workplaces. Finally, the aquaculture sector is committed to deliver economic growth, rural development, job creation and domestic and international trade (DFO, 2013b).

In a Canadian context I believe that to achieve sustainability it is necessary to concentrate first on the environment in particular on environmental impact of aquaculture. Canadian aquaculture success and marketing strategy are highly dependent on water quality and a healthy ecosystem and, here in Canada, waters are for the most part pristine and unspoiled. It is therefore a social obligation for aquaculture to be able to pair production and economic gain with protection of the environment in which the industry operates. It is a moral obligation for the industry to return to the Canadians an environment as clean and unaffected as possible.

Environmental sustainability in Canadian aquaculture can be achieved with practices such as integrated multi-trophic aquaculture (IMTA) which applies a balanced ecosystem approach in order to avoid undesirable shifts in pelagic and benthic processes (Chopin et al., 2001). In an IMTA setting, the wastes of one environment user become resources for another user, providing mutual benefits to the different cultured organisms (Chopin et al., 2001). Also bivalve aquaculture, in particular blue mussel and oyster culture, has shown to have positive ecosystem functions due to the natural bivalve filtration processes. Oyster and mussel culture can be used as an estuarine and coastal ecosystem restoration tool; it could serve to mitigate water quality issues, such as excess chlorophyll and turbidity. Bivalve aquaculture can therefore reduce the effects of eutrophication created by excess nutrients discharged in coastal waters from farm land runoff and coastal living (Burkholder & Shumway, 2011; Lindahl, 2011). The use of natural bivalve functions to counteract eutrophication could be a valuable tool along the parts of Canadian coast that are more affected by agricultural and coastal living runoff. It could also have the double advantage of increasing not only sustainability of the industry, but also acceptance of aquaculture by the general public.

Another basic aspect of sustainability is the welfare of the farmed animals. In order to be accepted by the public and to be seen as a sustainable industry, aquaculture needs to avoid the mistakes made by terrestrial animal farming industry. Respecting animal welfare is the base for increased growth and health; fish less stressed and crowded are clearly feeding better as well as less prone to diseases and infections. In addition, welfare is therefore the start point to achieve not only better production and health, but also a reduced use of drugs. Consequently maintaining the best possible animal welfare could increase the quality of the final product put on the market and the confidence of the public in the aquaculture practices. This aspect of sustainability is taken under great consideration in Canada, however the scientific knowledge about fish welfare keep increasing and evolving. In the same way, in order to remain sustainable, aquaculture practices need to keep change and evolve with it.

I believe that in Canada efforts are made to pursue sustainable aquaculture practices that protect and maintain the supporting environment by operating within the ecological limits. However, I also agree with Hargreaves (2011) when he states that sustainability is not an endpoint, but rather a trajectory of constant improvement. Therefore, even if aquaculture practices have been revised and changed, and even if great steps towards sustainability have been taken, we are not at an endpoint. Canadian aquaculture needs to keep up with time and with public demand. It needs to keep modifying, rearranging itself and striving towards sustainability. Aquaculture needs to move at the same pace and hand in hand with the best available scientific knowledge. Collaboration and communications between industry, regulators, scientists from different fields and the general public need to be implemented. This way we could secure a future for the Canadian aquaculture industry. This way we could obtain an industry progressing in line with the times, an industry that rises to the challenge of constant sustainable development.

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# Hannah Bradford

University of New Brunswick


**Define sustainable aquaculture in a Canadian context and describe what is required to achieve this goal**

**Introduction**

Sustainability is to meet the needs of the presents without compromising the needs of future generations. In an environmental context, sustainability includes non-resource depleting activities that do not alter the natural structure of the environment. Aquaculture is the growth and production of commercially reared species for food. Aquaculture production in Canada consists of the production of freshwater and marine finfish (trout, salmon, etc) and shellfish (mussels, oysters, clams, etc). Aquaculture has been around in Canada since 1980's and there has been an increasing demand on the industry with population growth. Demands on aquaculture have brought upon a growing concern for sustainable development of the industry. Aquaculture pollutes the environment through increased nutrient loading, changes to habitat structure, chemical therapeutants, alterations to light and escaped fish (DFO, 2010). Pollution from aquaculture must be reduced to the carrying capacity of the surrounding environment, leaving no residual impact on the ecosystem. Aquaculture geared toward a sustainable future will require changes to aquaculture site composition, management, design, and therapeutants; sustainable aquaculture will require both behavioral and physical changes to aquaculture site management that prevent and reduce pollution.

Preventative Measures

Increased nutrient loading from fin fish farms uneaten feed and excretory wastes alter the surrounding benthic and pelagic environment. Sustainable aquaculture should consist of reducing measures that are both preventative and subsequent to pollution. Preventative measures should have the most emphasis in aquaculture and begin with feed efficiency. Mandatory monitoring of feed distribution to a salmon cage using underwater video cameras can be used to quantify feeding limits on a cage basis. Close monitoring of salmon feed waste will is preventative of environmental impact and economically viable, increasing overall feed efficiency. Video capture could also be utilized to estimate the number of escaped salmon and promote behavioral changes to site workers. Feed efficiency can be increased but will need to be coupled with other site elements to be maximized.

The second step in preventing excess nutrients and organic loading is to capture excretory and feed waste by utilizing other species. Integrated Multi-Trophic Aquaculture pairs extractive aquaculture including species that can use inorganic (macro fauna) and organic (filter and deposit feeders) waste from fed aquaculture sites such as finfish (CIMTAN, 2011). In Canada, multi-trophic research and development combines the growth of salmon with organic filter feeders like the blue mussel and scallops, aquatic vegetation that intake inorganic nutrients such as kelp and organic deposit feeders including sea cucumbers, sea urchins and sea worms. A multi-trophic site design promotes the uptake of feed and excretory waste by other commercially important organisms. Multi-trophic aquaculture reduces fish farm wastes and boosts economic viability of the site by creating a poly-culture based system. IMTA is dependent on the synergism of species and their orientation to one another.

The concept of integrated multi-trophic aquaculture is enhanced when complimented by site-specific species placement. Research by the Canadian Integrated Multi-trophic Aquaculture Network to enhance species placement in multi-trophic site design will be an important factor in improving environmental sustainability of open water finfish aquaculture. Increases in surface area below cages to host deposit feeders and increase microbial uptake and breakdown have the potential to reduce the heavier fish deposits from reaching the ocean floor. Orientation of kelp and blue mussel or oysters directly adjacent to cages encourages the uptake of lighter molecules prone to stay in the water column longer. Better understanding of nutrient pathways for inorganic and organic molecules will maximize capture for food uptake and species growth.

Waste Removal and Dispersal

Waste removal and site rotation have the potential to help reduce the impact of aquaculture farms, in addition to preventative measures. Waste reduction after the fact includes the collection of wastes travelling to the sea floor. Designs for waste removal could include solar powered collector funnels to filter wastes from the water column. Excess wastes could be recycled as fertilizer. External (location) and internal (cages) site rotation is also be feasible to reduce site impact. Cage rotation that secures cages in different areas over time would disperse the immediate impact allowing natural processes including light penetration and turnover in the sediments to occur. Likewise, moving site leases or increased fallowing periods would reduce the impact to one area. Waste removal and dispersal decreases stress to the environment and the probability of reaching its carrying capacity.

Therapeutants

Sea lice are a problem faced by Canada's largest aquaculture industry, finfish. In the past industry has used chemical therapeutants to rid farms of sea lice, which is controversial as they affect the viability of other commercially valuable species and alter marine food web structure. Resolution to the use of chemo-therapeutants could include the use of well boats to administer all treatments, use of a more benign chemicals like hydrogen peroxide over other treatments, green technology like light based-traps or biological treatments using species such as cleaner wrasse or Blue Mussel (Martell et al., 2013). Research and development in non-chemical therapeutants will benefit the sustainability of these practices. A shift from past chemical treatments is crucial to the sustainability of marine aquaculture and the environment.

Closed System Aquaculture

Closed system for fish production is another aquaculture type to consider. Canada is one of the Earth's most water rich countries and produces tilapia and trout in closed system cages (DFO, 2008). Closed system pens are resource intensive needing energy for various site and treatment components, require water flow through, and have animal wellbeing treatment issues (DFO, 2008). Other issues include pathogen outbreak and risk management (DFO, 2008). Closed-pen aquaculture in Canada is a feasible option with the sustainable energy sources (wind, hydro or solar).

**Conclusion**

Sustainable aquaculture in Canada will comprise poly culture sites, increases in feed efficiency, site waste removal and dispersal as well as shift to natural or biological therapeutants. Sustainable aquaculture should rely on more preventative measures that capture excess feed or salmon waste before dispersal into the environment. Waste removal and dispersal could increase the assimilative capacity of aquaculture hosting environments. Capture of excesses wastes can be through behavioral changes and the rearing of synergistic species at a site. Sea lice treatment requires a better understanding of interactions between natural and biological therapeutants. Closed system aquaculture is also a feasible option for facilities with access to renewable energy sources and space. Sustainability is an important movement for the longevity of an industry and will be dependent on a holistic approach to aquacultural practices.

**References**

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# Student Scholarship Winners

There were three scholarship winners in 2014, Allie Byrne and Robert Bourdon from the University of Victoria and Chris Small from the University of New Brunswick, Fredericton.

Professor R. Moccia awarding student scholarships at AC 2014 in St. Andrews, New Brunswick, Left: Allie Byrne; Right: Chris Small (absent: Robert Bourdon).

# Student Poster and Presentation Awards

Each year, with the help of volunteer judges, a best poster and best oral presentation are awarded. This year's winners are: best poster, Jamie Lim and best presentation, Paul van Dam-Bates. Thank you very much to all the judges for their participation.

Professor R. Moccia awarding Paul van Dam-Bates the best presentation award at AC 2014 in St. Andrews, New Brunswick (absent: best poster winner Jamie Lim).