

Social aspects of the sustainability of integrated multi-trophic aquaculture

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Abstract A pilot project in the Bay of Fundy, Canada, is growing kelps, mussels, and salmon in an integrated multi-trophic aquaculture (IMTA) system. Biological and economic results are positive, but social acceptability is also a critical component of aquaculture sustainability. Focus group sessions with several segments of the population (restaurateurs, residents of communities near aquaculture facilities, and the general population) were held and the participants' knowledge of, and opinions on, IMTA were recorded. Most participants felt that IMTA had the potential to reduce the environmental impacts of salmon farming, benefit community economies, and improve industry competitiveness and sustainability. All felt that seafood produced in IMTA systems would be safe to eat and 50% of the participants were willing to pay 10% more for these products if labelled as such. The participants felt that IMTA appears to be an improvement over current monoculture practices and would be cautiously welcomed in the marketplace. A promotional campaign educating the general public, food distributors, and other industry stakeholders about the positive benefits of IMTA would go a long way in gaining mainstream acceptance of this aquaculture practice.

Keywords Integrated multi-trophic aquaculture · Social perceptions

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Abbreviations

BSE	Bovine spongiform encephalopathy
CFIA	Canadian Food Inspection Agency
DFO	Department of Fisheries and Oceans, Canada
EU	European Union
GMO	Genetically modified organism
IMTA	Integrated multi-trophic aquaculture
PCB	Polychlorinated biphenyl
PR	Public relations
UNB	University of New Brunswick

Introduction

Sustainability of aquaculture not only requires that it has a neutral (if not benign) effect on the environment but also that it be economically feasible. A further condition is that of social acceptability; that attitudes towards the sector are at least neutral. Enough evidence around the world demonstrates the detrimental effect on the industry if social perceptions are hostile. Shrimp farming in India has prompted sabotage and litigation (Ridler and Hishamunda 2001). In North America, individual homeowners and communities have opposed salmon farming because of perceived environmental damage or for aesthetic reasons (such as cluttered views of the seascape) (Ridler and Hishamunda 2001). Some other issues associated with the negative perception of aquaculture include heavy metals and toxins in shellfish and fish (Kruzynski 2004), genetically modified organisms (GMOs) (Bartley and Hallerman 1995), sea lice (Johnson et al. 1996), and genetic pollution of wild fish populations (Boyd 2003; Read and Fernandes 2003).

If IMTA is to be acceptable in the mind of the general public, the biological potential of the species in question must be appropriate to the environment, the local communities should benefit, and consumers must be willing to purchase the end product (Gempesaw et al. 1995). The IMTA concept seems to remedy some environmental effects of salmon farming; it also has positive economic benefits for the farmer because diversification generates additional revenues while reducing risk. The latter is important if prices of farmed salmon continue to decline (Whitmarsh et al. 2006). This paper focuses on the social acceptability of IMTA.

A research team from the University of New Brunswick (UNB) in Saint John and the Department of Fisheries of Oceans (DFO) Biological Station in St. Andrews has been running a pilot project in the Bay of Fundy, Canada, where kelps, mussels, and salmon are being grown together. The objective of the study was to see if several species could be grown safely (meeting the food safety requirements of the Canadian Food Inspection Agency—CFIA), efficiently (grown to market size in a reasonable timeframe while being cost-effective), and in an environmentally responsible manner (reducing the environmental impacts of the fish farm). Results show that:

1. the seafood products meet CFIA food-safety requirements (Haya et al. 2004);
2. mussels grow 50% faster in weight and kelps increase their biomass production by 46% when grown in proximity to salmon aquaculture sites (Chopin et al. 2004; Lander et al. 2004); and
3. the kelps and mussels are excellent candidates for biomitigation of dissolved inorganic and particulate organic matter (Chopin et al. 2004; Lander et al. 2004).

The next phase of this research project was to ensure that the seafood products are acceptable in the minds of the consumer; otherwise the financial priorities of the aquaculture companies will not be met. Although research results on the biological aspects (Stirling and Okumus 1995; Parsons et al. 2002; Chopin et al. 2004; Haya et al. 2004; Lander et al. 2004; Neori et al. 2004; Halling et al. 2005) and economic viability (Wowchuck et al. 2005; Whitmarsh et al. 2006) of IMTA systems are documented in the literature, research on the public's perception of aquaculture practices is lacking. Most of the information circulating about this topic is subjective and unsubstantiated, typically in the form of media reports (CBC 2003; Mercer 2005). Therefore a study was needed to determine if consumers are ready to purchase and eat the seafood produced from IMTA systems. A review by Kaiser and Stead (2002) discussed how uncertainty (e.g. negative images held by the general public) surrounding the development of the aquaculture industry might prevent it reaching full growth potential. The Department of Fisheries and Oceans (DFO) Canada commissioned a report on Canadians' perceptions, attitudes, and concerns toward aquaculture in general (DFO 2005). The Seafood Choices Alliance (2003) also conducted a survey in the European Union (EU) where they questioned people regarding their knowledge of and willingness to purchase environmentally friendly seafood. However, these reports did not specifically explore the public's awareness of IMTA, an area where information is lacking.

Research with focus groups was chosen because this methodology appeared well suited to the goal of studying social responses to IMTA. Focus groups are socially oriented vehicles for extending public participation (Bloor et al. 2001). Focus groups place people in natural settings where they are encouraged to discuss issues (Krueger 1994). In real life, people are influenced by the comments of others and make decisions after listening to the counsel of others around them. Additionally, focus groups allow the moderator to probe thoroughly unexpected issues, which may be important. This type of flexibility is not always an option in more structured surveys and experiments.

Focus groups were designed to determine the knowledge level and perceptions of current and proposed aquaculture practices of several target populations in the province of New Brunswick (NB), Canada. In the sessions, they were informed about IMTA systems and their opinions regarding this aquaculture practice and the food produced in that manner were noted. The primary objective of this study was to determine if the public would be willing to consume seafood products that were produced from an IMTA system, where the waste of one species becomes the treasure of another. The focus groups would also provide insight into people's knowledge level and perceptions of aquaculture practices, and what aspects of food safety they considered important. Overall, this study will contribute to determination of marketing strategies for seafood products from IMTA systems.

Materials and methods

Three populations were targeted: restaurateurs, residents of areas near aquaculture facilities, and the general population. The restaurateur group consisted of restaurant owners, managers and chefs all of whom serve seafood and aquaculture products at their establishments. All the businesses were located in Saint John County, NB, Canada. Restaurateurs were contacted by telephone and meetings were arranged to discuss participation. Charlotte County residents were individuals who live in an area (Charlotte County, NB) where the aquaculture industry has a strong presence. They had also participated in aquaculture surveys distributed previously by UNB, and were contacted by

post and telephone. The general population was composed of the wider range of the public who regularly consumed seafood. Posters were placed on boards around the campus of UNB, and campus wide emails were sent to students/faculty/staff/alumni of UNB. They were invited to participate in the focus group as long as they confirmed they regularly consumed fish and seafood.

The individuals who participated in this study were of mixed gender, ranged in age from 20 to 70 years, and encompassed a wide range of employment sectors, including students, academia, government, retired people, restaurant owners, managers, and chefs.

Five focus groups were conducted between August 2 and September 19, 2005, with a total of 23 participants. Four focus groups were held on the campus of the University of New Brunswick, Saint John, NB, and another was held at the Atlantic Salmon Federation in St. Andrews, Charlotte County, NB. All respondents received an incentive payment of \$10/h for their participation, at the end of the session.

All focus groups were conducted along the lines of the discussion guide, the questions of which have been included in the results and discussion section of this manuscript. In addition to the discussion guide, a video (AquaNet 2004) outlining an ongoing IMTA pilot project in the Bay of Fundy was shown to the participants in order to facilitate discussion.

Results and discussion

Aquaculture at the present time

1. How would you define success in terms of the aquaculture industry?

Restaurateurs defined success in terms of the aquaculture industry as raising a high quality, healthy, product which could be distributed easily. They also felt it must be environmentally sustainable. Charlotte County residents defined success in terms of the aquaculture industry as being profitable, sustainable, environmentally responsible, producing a quality product, and holding good public perception. The general population defined success as having the ability to get the product to the market cheaply, meeting supply and demand, and also having a large market-share. They also felt that successful aquaculture industries produce good quality seafood, at a profit, but without damaging the environment.

All groups emphasized that making a profit, raising quality products, and not harming the environment were key to making the aquaculture industry successful. It is also important to note that they all linked success with sustainability.

2. What areas are critical to the success of the aquaculture industry?

Restaurateurs felt that positive public perception, creating employment opportunities, environmental responsibility, profitability and protecting cultural heritage are all critical to the success of the aquaculture industry. Charlotte County residents felt that proper management, positive public perception, creating employment opportunities and environmental responsibility were critical to the success of the aquaculture industry. The general population felt that meeting supply and demand, protecting the environment, and creating employment opportunities with a reliable labour force were critical to the success of the aquaculture industry.

A common thread through all the groups was that a positive public perception, employment opportunities, and environmental responsibility were all critical to the success of the aquaculture industry. This suggests that good management and being sensitive to the culture of the people in the area, in addition to creating jobs that do not harm the

environment, will help ensure a successful operation. Bringing together all partners in the aquaculture industry (business officials, government regulators, general workforce) and discussing what the needs of each group are could potentially help. The DFO study (2005) indicated that participants knew, believed, or had heard mostly positive things about aquaculture's economic viability, the employment it created, and the idea that it ensured the survival of wild stocks brought about by over-fishing. Thus, if people viewed aquaculture as a good source of employment which did not harm the environment it may be much more acceptable.

3. Which of these areas need to improve and how?

Restaurateurs felt that public perception was the most critical. They recommended the creation of an industry public relation (PR) spokesperson position to cover media issues and public education campaigns. This PR person could speak for the aquaculture industry as a whole and not just for a single company. Restaurateurs also stated that product selection and freshness needed to improve. They recommended that farmers grow different types of product besides salmon.

Charlotte County residents said that both management and enforcement needed to improve. To improve these areas they recommended that aquaculture companies hire skilled labour and ensure all rules and regulations are followed. They wanted government (or whichever agency is responsible) to enforce penalties on people/companies who break the rules. The Charlotte County residents also felt that environmental sustainability needs to improve and they suggested using crop rotation theory, where some areas are left to lay fallow for a period of time, to help in this area.

The general population felt that public perception needed to improve. They suggested educating all role-players in the industry from farmers to distributors to consumers to help alleviate this problem. The general population also felt that environmental sustainability needs to improve, and they also suggested crop rotation theory and proper governance (both from federal and provincial governmental agencies, and from within the aquaculture industry itself) as ways to help mitigate the problem.

All groups felt that public perception, environmental sustainability, and proper governance were areas that need improvement. A PR spokesperson, crop rotation theory, and government enforcement were suggested as ways to mitigate these respective issues. Concerning the point of proper enforcement, the DFO study (2005) also reiterated the fact that the general public felt that the Canadian government should take a stronger role in enforcing regulations applicable to aquaculture leases.

General understanding of IMTA

Pre-video understanding of IMTA

1. Have you ever heard of the term “integrated multi-trophic aquaculture”?

Most (78%) of the participants in the focus groups had never heard of the term IMTA. In fact, in a study commissioned by DFO (2005) most participants never even heard of the term “aquaculture”. In that study some thought it meant fish farming, while a very few participants knew that aquaculture could also include plants and shellfish, both of which being positively perceived, unlike fish.

2. If so, what do you think it means?

Restaurateurs thought that IMTA meant farming more than one species at one time. Residents of Charlotte County, where most aquaculture occurs, recognized that IMTA meant growing multiple species that are compatible with each other, together in the same

Table 1 Participants' post-video understanding of the potential impacts of IMTA

Question 3: Do you think that IMTA has the potential to:	Yes (%)	No (%)	Maybe/not sure (%)
Reduce the environmental impact of salmon farming?	65.2	4.4	30.4
Improve waste management in aquaculture?	100	0	0
Reduce possible disease outbreaks?	21.7	34.8	28.5
Replenish natural stocks?	22.7	54.6	22.7
Improve food quality?	31.8	27.3	40.9
Increase employment opportunities?	90.9	0	9.1
Improve community economies?	95.5	0	4.5
Increase industry competitiveness?	95.5	0	4.5
Increase food production?	100	0	0
Improve sustainability of aquaculture overall?	72.7	0	27.3

location. The general population thought that IMTA meant having different components working together in one system; the different types of organism support each other resulting in less waste in the ecosystem.

Post-video understanding of IMTA

Table 1 outlines the participants understanding of the potential impacts of IMTA after watching a video summarizing a pilot IMTA project in the Bay of Fundy, Canada. In summary, people appeared sceptical or unsure if IMTA could improve disease outbreaks, replenish natural stocks, or improve food quality. However, people felt that IMTA had the potential to reduce the environmental impact of salmon farming, while improving waste management in aquaculture, creating employment opportunities, benefiting community economies, and improving industry competitiveness, food production, and the sustainability of aquaculture overall.

Environmental quality

1. How do you define environmental sustainability and is it important to you?

Restaurateurs defined environmental sustainability as not having an effect on the species naturally occurring in the area, or the environment, or any ongoing activities in that area—whether those activities were natural or anthropogenic. Charlotte County residents defined environmental sustainability as not changing the environment; any activity should be 100% reversible. The general population defined environmental sustainability as maintaining the same level of producers, consumers, and bacteria so the ecological functions remain stable.

When attempting to come up with a definition for environmental sustainability, all groups touched on the idea that a sustainable activity should not hinder any other activity around it, whether it is environmental or economic in nature. Biologically, the species and the trophic levels that exist in the environment should not change during any activity. If a change takes place, when that activity stops, the environment should be able to revert to the way it was before the activity occurred. All participants felt very strongly that environmental sustainability is important. The participants in the DFO (2005) and EU (Seafood Choices Alliance 2003) studies also indicated that environmental sustainability was very important to them.

2. Is food recycling acceptable?

Restaurateurs felt that it was acceptable to recycle plant material but not animal parts. They were aware of the health problems associated with recycling animal protein in animal feed and mentioned Bovine spongiform encephalopathy (BSE or “mad cow disease”) several times in the discussions. Charlotte County residents and the general population also shared this opinion.

Participants from all focus groups felt that some food recycling was acceptable; however, they felt strongly that there should be limitations on this practice. Media coverage of BSE has been extensive and people are aware that recycling some animal products and cannibalistic practices, in particular, are not healthy. These practices are not acceptable in the mind of the consumer. However, recycling of plant material seemed acceptable to the participants. Fears relating to BSE, and GMOs or “Frankenfish”, were also raised by participants in the DFO (2005) study, contributing to negative perceptions of aquaculture in general, although recycling of food in an IMTA system was not directly addressed.

3. Do you think that much food is wasted in current fish farming practices?

Most participants (94%) felt that food was being wasted in current aquaculture practices. All groups believed that a significant amount of the fish food was floating away from the cages or sinking to the sea floor. Charlotte County residents also felt that automated feeders were contributing to food wastage when not set properly.

4. Is there a need to improve current fish food, energy use, and recycling?

Most participants felt there was a need to improve the energy use from fish food, although a few participants from the general population were not sure what to say because they felt they were not familiar enough with current aquaculture practices.

5. If IMTA systems could improve fish food, energy use, and recycling would that be a good thing?

All participants felt that it would be good if IMTA systems could improve the energy use of fish food. They also felt that it would improve the public perception of the industry as well as being a way to reduce costs. However, Charlotte County residents were sceptical of industry motivation.

Food safety and marketing strategies

1. Do you read labels on food products?

Most (86.4%) participants said that they read food labels.

2. What should be on the labels?

Restaurateurs wanted as much information as possible on the labels. They distinctly mentioned site of origin, all ingredients (including what supplements, vitamins, or hormones might have been added), if the product was genetically modified, nutritional facts (e.g. calories, proteins, carbohydrates, and fat), and levels of heavy metals. Charlotte County residents wanted to see nutritional facts (e.g. proteins, carbohydrates, fat), chemical additives, and potential allergens. They also wanted to see the information presented in a consistent manner and in large enough fonts to be readable. The general population wanted to know site of origin, how it was produced, and what type of feed the animal was given. They also wanted to know nutritional facts (e.g. fat, carbohydrates, calories), if any toxins were present, price, and expiry dates.

A clear consensus across focus groups was that they wanted to see nutritional facts, chemical additives, and toxin levels clearly indicated on the labels of their food. Site of origin also seemed to be important.

3. If seafood was grown in an IMTA system should that be on the label?

Participant responses were divided concerning whether or not this information should be indicated on the labels. Restaurateurs wanted to see this information on labels; again this group wanted as much information as possible about the food products they served. Charlotte County residents did not think it should be on the labels, but it should be considered that this group stated that they wanted to minimize the information on labels. Most of the general population interviewed wanted to see this information on labels while a few said that it did not matter. People across all groups thought that it may be too complicated for the average consumer because not many people understood what IMTA was anyway.

People surveyed in the DFO (2005) study also had a mixed reaction to labelling. Some felt that a label would not act as a panacea; it would only fuel fear that there may be a problem. Others, however, felt it would ensure quality standards were followed and products would be safe to eat. It may be worthwhile to note that in a survey conducted in the EU (Seafood Choices Alliance 2003), it was found that 71% of respondents ($n = 1,000$) indicated that seeing an environmentally responsible label would make them more likely to buy a particular item. Therefore, if seafood produced in IMTA systems was marketed as coming from environmentally responsible culture systems then it may be more appealing to consumers. Different labelling according to specific markets would probably be advisable considering these responses.

4. Do you think that IMTA systems can be regarded as similar to recycling and organic production systems on land?

All participants felt that IMTA systems were similar to recycling and organic production systems on land.

5. What health concerns do you have about the seafood you eat? What should the seafood be tested for?

Restaurateurs felt that seafood should be tested for absolutely everything, including mercury (Hg), and any toxins or diseases that may be present (they were aware that different species are more susceptible to certain diseases, therefore testing should be done where appropriate). Charlotte County residents felt that seafood should be tested for heavy metals, particularly Hg, drugs and antibiotics, and any potential pathogens. The general population felt that seafood should be tested for heavy metals, particularly Hg, arsenic (As) and polychlorinated biphenyls (PCBs).

All focus groups were very concerned about the level of heavy metals, such as Hg, in their seafood. This is not surprising, because much media coverage has sensationalized this topic in recent years. This was also reported in the DFO (2005) study where those surveyed wanted to see information on labels regarding safe consumption frequency and the risks of eating farmed fish in relation to Hg, genetic modification, hormones, fish feed, and artificial colouring.

6. Do you think that seafood grown in proximity to salmon would be safe to eat?

All participants felt that seafood products grown in proximity to salmon farms would be safe to eat. They felt that normally many of these species co-exist in nature and disease transfer between different groups of organisms should not occur.

7. Would you be willing to eat seafood products grown in proximity to salmon?

All participants indicated they would be willing to eat seafood products grown in proximity to salmon farms.

8. Would you be willing to pay more for environmentally friendly seafood? If so, how much more?

Overall, participant responses were mixed (50% yes, 50% no) on whether or not they would be willing to pay more for environmentally friendly seafood. Most restaurateurs

(83%) were willing to pay more for environmentally friendly seafood. They felt that a 10% increase on market price would be acceptable. It would be expected that the cost would simply be passed on to the consumer and not directly absorbed by the restaurateur though, so this is probably a reflection of what they think their customers would be willing to pay. All the Charlotte County residents were not willing to pay more for environmentally friendly seafood. They were adamant that all food production should be environmentally friendly and there should not be two tiers of food production. The reaction from the general population was mixed (60% yes, 40% no). Many shared the view of eliminating two-tiered food production, and some mentioned that they simply could not afford to pay more. However, some were willing to pay more (up to 50% more) for what they consider environmentally friendly seafood.

The results for this question seem to be consistent with a survey conducted in the EU (Seafood Choices Alliance 2003), who found that 40% of people interviewed ($n = 1,000$) would be willing to pay 5–10% extra for sustainable fish.

Conclusions

Although only a small sample size was used for this study, some general trends and attitudes can be identified, and areas for future research. The people interviewed had mixed feelings about the IMTA concept. Some felt that this aquaculture practice has excellent potential to help mitigate the problems facing the aquaculture industry. However, many people remained unconvinced that proper management practices will be applied to any aquaculture system. According to the EU survey (Seafood Choices Alliance 2003), 76% of consumers felt they do not have enough information about the seafood available to them. The Canadians who participated in the DFO focus group study (2005) felt manipulated and misinformed because of the too dominant and negative information flow, which is noticeably uncontested. A review by Kaiser and Stead (2002) also highlighted the issue of trust as a major factor influencing the progress of the aquaculture industry from the public's viewpoint. Many participants in the focus group study reported in this paper also shared these viewpoints. However, despite these views, many consumers felt that aquaculture has tremendous potential, and some even wanted Canada to become a world leader (DFO 2005), because of the economic potential of the industry. On the basis of these results, increasing public education and industry responsibility should help improve current perceptions.

Generally, the participants felt that IMTA appeared to be an improvement over current aquaculture practices and would be cautiously welcomed in the marketplace. On the basis of the results of this study, and another survey from the EU (Seafood Choices Alliance 2003), there seems to be a market niche for sustainable seafood, which could be an advantage for IMTA. A 10% increase in market price seems to be acceptable to consumers, especially those who understand the environmental benefits of sustainable systems, for example IMTA. Because a lack of knowledge seems to be apparent from this study and other studies (Kaiser and Stead 2002; Seafood Choices Alliance 2003; DFO 2005), a promotional campaign educating the general public, food distributors, and industry stakeholders about the positive benefits of IMTA would go a long way in gaining mainstream acceptance of this aquaculture practice. This could be initiated with (among the other methods discussed in this paper) simple, yet informative labelling on packaging and the introduction of an unbiased aquaculture spokesperson who would inform the public about aquaculture issues.

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