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CLOSED CONTAINMENT SALMON AQUACULTURE

Report of the Standing Committee on Fisheries and Oceans

Rodney Weston
Chair

MARCH 2013

41st PARLIAMENT, FIRST SESSION

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First Session, Forty-First Parliament

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has the honour to present its

THIRD REPORT

Pursuant to its mandate under Standing Order 108(2) and the motion adopted by the Committee on Tuesday, October 18, 2011, the Committee has studied closed containment salmon aquaculture and has agreed to report the following:

TABLE OF CONTENTS

CLOSED CONTAINMENT SALMON AQUACULTURE REPORT 1
INTRODUCTION 1
BACKGROUND 2
A. Previous Committee Studies 2
B. Salmon Aquaculture in Canada 2
C. Current Salmon Aquaculture Farming Practices 3
CLOSED CONTAINMENT TECHNOLOGIES 4
A. Ocean-Based Solid-Wall Systems 4
B. Land-based Recirculating Aquaculture Systems (RAS) 6
C. Existing Closed Containment Aquaculture 7
D. Atlantic Salmon Commercial-Scale Pilot Projects 8
AgriMarine 8
'Namgis First Nation 9
Marine Harvest 9
POTENTIAL BENEFITS OF CLOSED CONTAINMENT AQUACULTURE 10
A. Reduced Business Risk 10
B. Reduced Environmental Impacts 11
C. Improved Socio-Economic Outcomes 14
THE ECONOMICS OF CLOSED CONTAINMENT AQUACULTURE 18
A. The Viability of Closed Containment Atlantic Salmon Aquaculture 18
B. Economic Feasibility Studies and Key Variables 20
C. Marketing of Closed Containment Salmon 22
INVESTMENTS IN CLOSED CONTAINMENT AQUACULTURE 24
A. Research and Development 24
B. Demonstration Projects 25
C. Access to Capital 27
D. Retaining Canada's Competitive Advantage 29
THE REGULATORY FRAMEWORK FOR AQUACULTURE 30
CONCLUSION 31
LIST OF RECOMMENDATIONS 33

APPENDIX A: LIST OF WITNESSES, 41st PARLIAMENT, 1st SESSION 35
APPENDIX B: LIST OF WITNESSES, 40th PARLIAMENT, 3rd SESSION 39
APPENDIX C: LIST OF BRIEFS, 41st PARLIAMENT, 1st SESSION 43
APPENDIX D: LIST OF BRIEFS, 40th PARLIAMENT, 3rd SESSION 45
REQUEST FOR GOVERNMENT RESPONSE 47

CLOSED CONTAINMENT SALMON AQUACULTURE REPORT

INTRODUCTION

On October 18, 2011, the Committee agreed to undertake a study on closed containment salmon aquaculture. The Committee has a history of interest in aquaculture, the latest example being in the 40th Parliament. At that time, a decision was made to begin an in-depth examination of the aquaculture industry across the country. This effort began in the Pacific region, but the study was incomplete at time of the election. The Committee agreed to consider evidence received and testimony heard from that study insofar as it was relevant to closed containment aquaculture.

The Committee convened 18 meetings between October 2011 and March 2012 to study the matter, hearing submissions and testimony from representatives of Fisheries and Oceans Canada (DFO), scientists and academics, the open-net pen aquaculture industry, the closed containment aquaculture industry, consultants, Aboriginal groups, environmental organizations, coastal communities, retailers, and recreational and commercial fishers (a complete list is attached to this report). The Committee members would like to express their sincere thanks to the witnesses who appeared before them to share their knowledge, experience and recommendations over the course of this study. These contributions were invaluable in the preparation of the following report, and the Committee members acknowledge those involved with gratitude.

The Committee traveled to Washington D.C. and West Virginia in March 2012 to hear from representatives of the National Oceanic and Atmospheric Administration and the United States Department of Agriculture with respect to American initiatives and priorities in aquaculture regulation, funding, and research and development. In West Virginia, the Committee visited one of the foremost closed containment aquaculture research facilities in the world in order to speak with the scientists and engineers engaged in this cutting edge research.

The Committee is pleased to present its report, in which it makes recommendations to the federal government. These recommendations are based on the testimony of witnesses as well as the Committee's own analysis of the issues.

BACKGROUND

A. Previous Committee Studies

The Committee last studied the issue of aquaculture between 1999 and 2003, which culminated in the April 2003 report: *The Federal Role of Aquaculture in Canada*.[1] In that 83-page report only one recommendation pertained to closed containment.[2] As a result of increased scrutiny on the environmental impacts of the aquaculture industry, closed containment technologies have become a major focus of aquaculture research and development. The fact that this report focuses entirely on closed containment aquaculture indicates how much the dialogue has changed over the last decade.

B. Salmon Aquaculture in Canada

Aquaculture accounts for 14% of total fish and seafood production in Canada by landed volume, or 35% by value.[3] Canadian aquaculture production includes several species of salmon, trout, mussels, and oysters. Salmon farming is by far the largest industry accounting for 63% by volume, or 75% by value of total Canadian production, the vast majority of which is Atlantic salmon. In 2010, Canada raised 101,385 tonnes of farmed salmon, for a total (farm gate) value of $690.9 million. The same year, Canada exported almost 80,000 tonnes of salmon, 98% of which was Atlantic salmon.[4]

The salmon aquaculture industry expanded dramatically over the course of the 1980s and 1990s. The Canadian industry experienced some declines during the early to mid-2000s due largely to disease outbreaks and global market factors.[5] While initially made up of many smaller companies, the salmon aquaculture industry has undergone considerable consolidation and vertical integration in Canada, with the vast majority of production now raised by just four companies in each of British Columbia and New Brunswick,[6] and three companies in Nova Scotia.[7] There are approximately 130 sites

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1 The House of Commons Standing Committee on Fisheries and Oceans. *The Federal Role in Aquaculture in Canada*, Ottawa, April 2003.

2 The Committee recommended: "That governments dedicate funds for research on the environmental effects of netcage systems, and the improvement of closed containment technology. These new systems should be phased in on a trial basis." Ibid., p. 50.

3 Fisheries and Oceans Canada, *Key Facts and Figures for Aquaculture in Canada*.

4 Statistics Canada, *Aquaculture Statistics*. Catalogue No. 23-222-X, 2010, p. 14.

5 Department of Fisheries and Oceans, Socio-Economic Impact of Aquaculture in Canada, 2010, p. 8-9.

6 Ibid., p. 11.

7 Atlantic Canada Fish Farmer's Association, *Fish Farming: Atlantic Canada's Vibrant and Thriving Industry*.

(80 active at any given time)[8] in British Columbia, 90 sites in New Brunswick[9] and 15 in Nova Scotia.[10] Newfoundland and Labrador had 12 sites as of 2010, but is experiencing significant growth in this sector.[11]

Globally, Canada produced about 7% of the world's farmed salmon in 2009, ranking fourth in terms of salmon aquaculture production, behind only Norway, the UK and Chile.[12] In 2010, Canada exported approximately 78,000 tonnes of farmed salmon to the US (approximately 77% of our total production) for approximately $525 million.[13] Canadian farmed salmon was also exported to Japan, France, Taiwan and other countries to a lesser degree.

There has been no significant growth in salmon aquaculture production in Canada over the past decade, with 2010 production volumes still slightly less than they were in 2001.[14] This is attributable to a variety of factors, including a decline in world prices for Atlantic salmon, a moratorium on new salmon farm licences in British Columbia, and new farm siting and environmental management requirements.[15] Industry representatives, however, have told the Committee that they believe the time is ripe for expansion again, as American demand is growing at a rate of 3% to 5% per year.[16]

C. Current Salmon Aquaculture Farming Practices

The vast majority of salmon farmed in Canada and around the world are Atlantic salmon that are raised in open-net pen aquaculture farms in coastal areas in the ocean. Atlantic salmon has become the species of choice for aquaculture producers due to a number of factors, including market demand, relatively rapid growth rates, less aggressive behaviour, and superior disease resistance.

In conventional net pen operations, salmon spend about one third of their lives in closed containment systems at a hatchery. When the salmon smolts are approximately

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8 British Columbia Ministry of the Environment, *Salmon Aquaculture in British Columbia, 2010 Quick Facts*.

9 Department of Fisheries and Oceans, Socio-Economic Impact of Aquaculture in Canada, 2010, p. 8-9.

10 Atlantic Canada Fish Farmer's Association, *Fish Farming: Atlantic Canada's Vibrant and Thriving Industry*.

11 Department of Fisheries and Oceans, Socio-Economic Impact of Aquaculture in Canada, 2010, p. 41.

12 Food and Agriculture Organization of the United Nations, Fisheries and Aquaculture Department, Fishery Statistical Collections, Global Aquaculture Production, FAO Yearbook of Fishery and Aquaculture Statistics Summary Tables, 2009.

13 Statistics Canada, *Aquaculture Statistics*, Catalogue No. 23-222-X, 2010, p. 17.

14 Ibid., 2009, p. 11.

15 Department of Fisheries and Oceans, 2010, Socio-Economic Impact of Aquaculture in Canada, p. 8-9; and Agriculture and Agri-Food Canada, International Business, Fish and Seafood, Fact Sheets, Farmed Salmon.

16 Clare Backman, Director Sustainability, Marine Harvest Canada. Committee *Evidence*, November 1, 2011.

12 cm in length or 100 g (12 to 18 months after hatching), they are transferred to net pens in the ocean, where they stay and grow for an additional 18 to 24 months before being harvested. Atlantic salmon are typically considered to be of harvestable size when they are approximately 4.5 to 6 kg.

Salmon aquaculture sites vary in size, but they typically consist of a series of 6 to 24 floating, mesh cage-like structures made of plastic, steel and/or aluminum. Salmon farms are usually located in sheltered bays and fjords where they will be protected from extreme currents and storms, and are anchored to the ocean floor to keep them in place.

Farmed salmon are fed dry pellets consisting of fish meal, fish oil and plant proteins, enriched with vitamins, minerals and carotenoids. The fish meal and fish oil are derived from small wild fish such as anchovy, menhaden and capelin, obtained primarily from South America. Much research has been conducted, however, in an effort to reduce the amount of fish meal and fish oil required to produce the feed for farmed salmon.

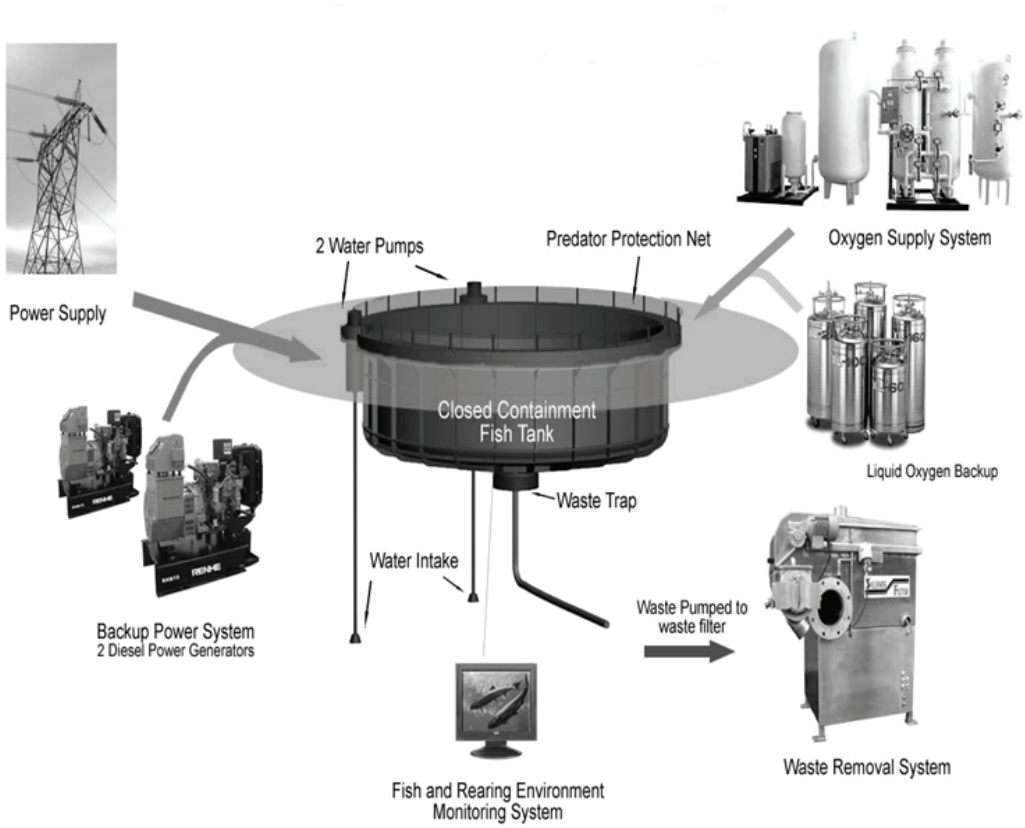
CLOSED CONTAINMENT TECHNOLOGIES

Closed containment aquaculture refers to a number of technologies that seek to isolate the rearing environment from the natural environment in order to reduce or eliminate the interactions between the two. Not all types of closed containment systems are entirely separated from the natural environment, and as a result some are more "closed" than others. While a number of different technologies and systems have been designed and piloted over the years, the two most relevant technologies that seem to have emerged for the Canadian salmon farming industry are ocean-based solid-wall containment systems and land-based, recirculating aquaculture systems (RAS).

A. Ocean-Based Solid-Wall Systems

Ocean-based solid-wall containment systems consist of solid-walled fibre and foam composite tanks ranging in size from 3000 m^3 to 10,000 m^3 that float at the surface of the water. The water intake allows water to be drawn into the tank from varying depths (which provides for control over water quality and temperature). Supplemental oxygen is pumped into the tank to maintain optimal dissolved oxygen levels. Waste feed and feces are filtered out via a drain at the bottom of the tank and pumped away with the expectation that it could be treated for disposal on land as a fertilizer, while the remainder of the relatively clear water is allowed to overflow over the top of the tank into the surrounding waters.

Figure 1: The AgriMarine Closed Containment System[17]



Such systems are not completely closed because the intake water is not treated before entering the tank and water from the tank is released back into the ocean. Nevertheless, the system is successful in removing 90% of settleable wastes, which, in an open-net pen aquaculture system, would otherwise settle to the ocean floor or be dispersed by ocean currents. In addition, due to the solid walls, the system provides for separation of wild and farmed populations and reduces the risk of escapes and predation. As stated by Robert Walker of AgriMarine Industries:

> Our technology provides what net cage farms cannot. These features allow us to farm in adverse conditions year round and operate well above density levels practical for net cages without causing undue stress to the fish. The solid-wall system also contributes to a healthier surrounding ecosystem… The waste removal process eliminates the undesirable addition of nutrients to local marine ecosystems. With solid-wall

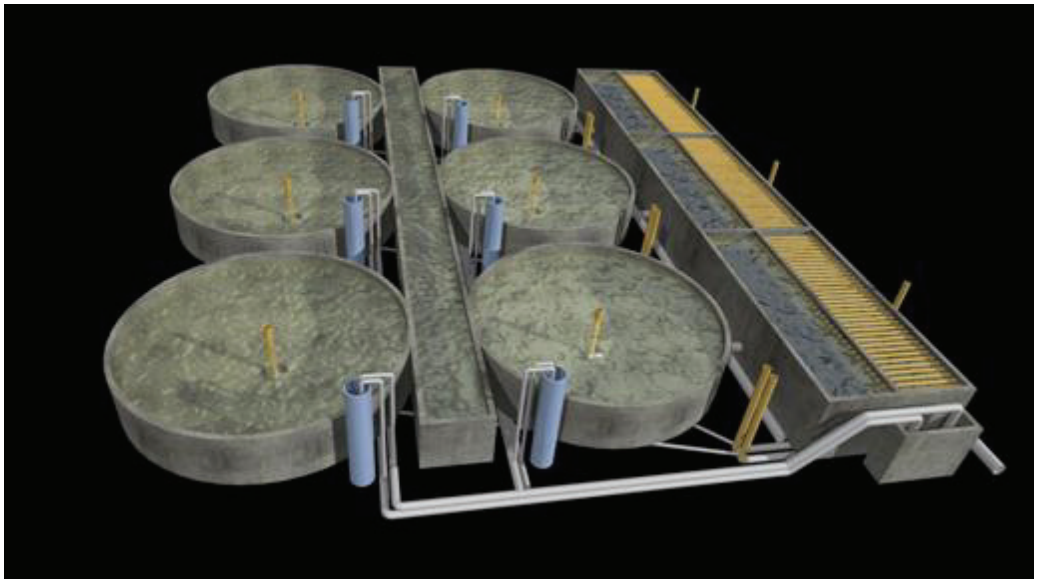
17 AgriMarine Industries Inc., Brief. December 1, 2011.

containment there's no possibility of interaction between farmed and wild, no fish escapes, no predator interactions.[18]

B. Land-based Recirculating Aquaculture Systems (RAS)

Land-based RAS use large, circular concrete tanks arranged in modules on land. Because the tanks are land-based, they must be located in proximity to an adequate supply of either groundwater or seawater. Water is pumped into the tank and continually recirculated; water quality is maintained through various means, including mechanical filtration, UV irradiation, CO_2 strippers and ozone injection. Solid wastes are drained out the bottom of the tank and removed to a settling basin, and can ultimately be treated to be used as compost or fertilizer. Through this constant recirculation and treatment of water, these systems can reuse 98% of the input water.

Figure 2: Land-Based RAS Closed Containment System[19]



Land-based RAS are designed to physically separate fish from the external environment. Because water is treated before entering the tanks and no water is released to the natural environment, there are virtually no vectors for disease, pathogen or parasite transfer between wild and farmed populations. These systems also offer near complete control over water quality, temperature, oxygenation and other parameters, although electricity and technology requirements are necessarily greater.

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18 Robert Walker, President, AgriMarine Industries Inc., Committee *Evidence*, December 1, 2011.

19 Department of Fisheries and Oceans, Brief, October 27, 2011.

C. Existing Closed Containment Aquaculture

Closed containment technologies, including RAS, have existed for several decades and are currently available as commercial, off-the-shelf systems from a number of different vendors.[20] Most of these technologies have been developed or refined for the global closed containment aquaculture industry for other species, as well as for the existing closed containment salmon broodstock and hatchery facilities.

The Committee learned that closed containment systems are currently used successfully (and profitably) at commercial scale for other species such as tilapia, sturgeon, arctic char, and trout. Target Marine Hatcheries, for example, in Sechelt, BC, raises sturgeon in a land-based RAS facility for the production of both caviar and sturgeon meat. Tilapia is similarly raised in land-based RAS in Ontario, Alberta and BC.

Although there are not yet any commercial-scale closed containment systems raising Atlantic salmon anywhere in the world, closed containment technologies already play a significant role in parts of the farm-raised Atlantic salmon growth-cycle, both in Canada and abroad. The Committee heard from Marine Harvest that their salmon spend approximately the first third of their lives in closed containment RAS (up to the point where the smolts are transferred to the net pen sites). In addition, half of their broodstock is raised entirely in a dedicated RAS facility.[21] These practices are now common in the industry in order to exercise greater control over environmental factors and reduce business risk.

There are a small and growing number of closed containment aquaculture facilities in British Columbia, Montana and Washington State that are producing Pacific salmon commercially. While Atlantic salmon farms are typically considered to be "commercial-scale" at 1000 tonnes production capacity, Pacific salmon can be raised profitably at the 100 tonnes to 200 tonnes scale. Coho salmon, it was explained to the Committee, provide better opportunities for niche marketing (thereby fetching a higher price per kilogram); but because Atlantic salmon are a global commodity product, significantly larger economies of scale are required in order to be profitable.[22]

One of these land-based RAS raising Pacific salmon is Swift Aquaculture, in Agassiz, BC. The farm raises coho salmon in freshwater tanks, and also operates as a multi-trophic aquaculture site, using the nutrient-rich water from the salmon tanks to grow watercress and wasabi, which in turn produces algae to feed crayfish. The coho salmon from this farm is currently sold to high-end restaurants in Vancouver. Plans exist to expand

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20 Dr. Andrew Wright, Technology Advisor, SOS Marine Conservation Foundation, Committee *Evidence*, May 12, 2010.

21 Clare Backman, Marine Harvest Canada, Committee *Evidence*, November 1, 2011.

22 Daniel Stechey, president, Canadian Aquaculture Systems Inc., Committee *Evidence*, November 1, 2011.

this site to a 1000 tonnes RAS operation. Additionally, as John Holder of JHL Consulting has testified, the farms can be flexibly located as long as the land price is not exorbitant:

> These farms can be put in urban areas, not necessarily rural ones. They do not have to be near a body of water…We can set up close to the markets, which is going to cut down our transport cost.[23]

Coho salmon are also raised by AquaSeed Corporation at their 100 tonnes land-based RAS facility in Washington State, as well as through a joint venture with Teton Fisheries at two 160 tonnes facilities in Montana. These coho are marketed under the brand "SweetSpring Salmon," which supplies Overwaitea Food Group supermarkets in British Columbia and Alberta.

D. Atlantic Salmon Commercial-Scale Pilot Projects

Despite the challenges anticipated in attempting to grow Atlantic salmon in closed containment units at a production cost that will be competitive with global open-net pen salmon aquaculture production, a significant amount of research and a number of pilot projects have already been carried out. While some past pilots have demonstrated that some technologies are not feasible for Atlantic salmon production, there are currently at least three projects at various stages of construction or engineering in Canada that seek to demonstrate the potential to ultimately expand beyond the pilot-scale to full, commercial scale production: the AgriMarine project at Middle Bay, the K'udas project with the 'Namgis First Nation, and Marine Harvest's planned pilot (in cooperation with the Canadian Alliance for Aquaculture Reform) on northern Vancouver Island.

AgriMarine

As described above in the section on closed containment technologies, AgriMarine Industries Inc. operates an ocean-based solid-wall containment pilot project near Campbell River, on Vancouver Island. The project, operated in cooperation with the not-for-profit Middle Bay Sustainable Aquaculture Institute has received funding from Sustainable Development Technology Canada (SDTC) and the Gordon and Betty Moore Foundation in order to carry out the initial phases. The first 3000 m^3 floating tank was installed in the bay in January 2011 and was stocked initially with chinook salmon fingerlings. While the first harvest was scheduled for late spring or early summer of 2012 a severe wind storm in March 2012 resulted in some structural damage to the demonstration tank and the decision to conduct an early harvest.[24] The three remaining tanks have been redesigned and installation was planned for 2012, which would raise the

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23 John Holder, President, JHL Consulting, Committee *Evidence*, November 24, 2011.

24 AgriMarine Sustainable Aquaculture Systems. News Releases. “AgriMarine Announces First Salmon Harvest from Canadian Demonstration Site”, March 27, 2012.

total annual production of the site to approximately 900 tonnes. According to Robert Walker, the President of AgriMarine Industries Inc., the company is "very close to commercialization."[25]

'Namgis First Nation

The K'udas Project is a collaboration between the 'Namgis First Nation and the SOS Marine Conservation Foundation to build a pilot-scale land-based RAS on the Cheslakees Indian Reserve, 5 km south of Port McNeill on Vancouver Island. The project has been designed such that, initially, only one module with an annual production capacity of 260 tonnes to 500 tonnes will be installed. Data collected from pilot operations will then be used to refine the design where necessary and to expand to a full-size, commercial-scale facility with an annual production capacity of 1000 tonnes.

The project has been designed with a number of innovative features intended to reduce operating costs and maximize revenues, including heat recovery and heat pump technologies that are estimated to reduce energy costs by a factor of 10. The site is also being designed to eventually accommodate aquaponics, whereby the nutrient-rich effluent water will be used to grow plants in greenhouses.

The project has received funding from SDTC, Tides Canada and the Coast Sustainability Trust to assist with the initial $6 to $7 million in capital costs associated with the project. Site clearing work began over the winter of 2011-2012 and construction was to be completed by August 2012. The intention was for the first production cycle of Atlantic salmon to take place between September 2012 and September 2013.

Marine Harvest

The Committee heard from Marine Harvest Canada that the company is planning to undertake a pilot project in order to document the actual costs and benefits of commercial scale RAS production, and to contrast the collected information with the figures for conventional net pen production. Marine Harvest engaged the engineering firm Worley Parsons to conduct a site selection survey, prepare an engineering proposal and conduct a life-cycle analysis of the systems. This preparatory work has been completed, and the cost of a 300 tonnes per year pilot on the east coast of Vancouver Island was estimated at $8 million.[26] Partial funding for the project was committed by DFO and SDTC. Although Marine Harvest had intentions to proceed based on these preliminary studies, a reduction in the world market price of salmon resulted in the required $5 million in funding from Marine Harvest's parent company not being approved at this time, and the project

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25 Robert Walker, Committee *Evidence*, December 1, 2011.

26 Clare Backman, Committee *Evidence*, November 1, 2011.

was put on hold while alternative funding sources are being sought out or until the market price of salmon improves.[27]

POTENTIAL BENEFITS OF CLOSED CONTAINMENT AQUACULTURE

The Committee heard extensive evidence about the potential benefits of closed containment salmon aquaculture. These include the potential for reduced business risks, reduced environmental impacts and improved socio-economic outcomes.

A. Reduced Business Risk

Open-net pen aquaculture involves risks because it is exposed to external environmental hazards. As explained by the Canadian Aquaculture Industry Alliance, some of these hazards include: the exposure to diseases or parasites carried by wild fish; water quality or pollution issues; storms; escapes or predation. Losses in Chile due to disease were alluded to a number of times. In Canada, one producer noted their experience with losses due to poor water quality that had affected their outlook on net pen aquaculture:

> We actually were net cage farmers — we grew chinook salmon on the northwest coast of Vancouver Island for quite a few years — and ended up losing our farms because of several significant losses of fish due to uncontrolled plankton blooms in the area. We wanted to stay in the salmon farming business, but we didn't want to keep losing fish...[28]

It was a desire to reduce these business risks that initially prompted aquaculturists to conduct research into closed containment technologies,[29] similar to what they have used for smolts and broodstock production. AgriMarine gave up net pen production entirely and began pursuing closed containment due to a series of large stock losses for the company in the 1990s, and other companies are still investigating the economics. Marine Harvest Norway, for example, signed an agreement with AgriMarine in early 2012 to test AgriMarine's technology to support post-smolt production of fish up to 1 kg with the aim of demonstrating "the economic benefits of the AgriMarine System over conventional net cage systems."[30] Marine Harvest Canada also has plans to investigate the economics of lengthening the amount of time young salmon are raised in RAS before being transferred to net pens, thereby reducing the amount of time the fish are exposed to the

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27 Ibid. and Speaking Notes, November 1, 2011.

28 Robert Walker, Committee *Evidence*, December 1, 2011.

29 Ruth Salmon, Executive Director, Canadian Aquaculture Industry Alliance, Committee *Evidence*, November 1, 2011.

30 AgriMarine Sustainable Aquaculture Systems, AgriMarine Signs Letter of Intent with Marine Harvest Norway, February 12, 2012.

risks of the ocean growing environment, as well as potentially reducing total production times by optimizing the growing conditions.[31]

B. Reduced Environmental Impacts

The Committee heard a great deal of testimony about the impacts of open-net pen salmon farming on wild fish and the environment. Some of the most commonly cited concerns include:

- The transfer of sea lice between wild and farmed salmon as the wild salmon migrate past open-net aquaculture sites;

- Contaminants (including fish waste and excess feed, pesticides, antibiotics, feed additives, antifouling agents, etc.) polluting the local aquatic environment, altering habitat and harming other species;

- The transfer of infectious diseases such as infectious salmon anemia (ISA); and

- The risk of escaped farmed salmon breeding with or out-competing wild salmon;

Stakeholders and scientists, however, have differing views on the extent and severity of these impacts, and the impacts likely vary from the East Coast to the West Coast. The Government oversees the conduct of open-net pen aquaculture through regulations and management practices. However, some believe that the environmental impacts are more serious or long term, and they therefore advocate for a transition to closed containment aquaculture as a solution to some of these challenges.

Representatives of the open-net pen salmon aquaculture industry, on the other hand, reiterated to the Committee that although open-net pen salmon aquaculture production can temporarily affect the local environment, the existing environmental assessment process for each proposed salmon farm ensured that these impacts were mitigated to the furthest extent possible and that any remaining environmental effects were not significant.[32]

However, a number of academics and representatives of environmental organizations felt strongly that sufficient evidence exists to demonstrate that open-net pen salmon aquaculture is likely having a negative impact on wild salmon populations and other elements of the ecosystem.

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31 Clare Backman, Committee *Evidence* and Speaking Notes, November 1, 2011.

32 For example: Ruth Salmon, and Daniel Stechey, Committee *Evidence*, November 1, 2011.

The data pertaining to the extent of the environmental impacts of salmon aquaculture are inconclusive. Substantial disagreement remains among scientists as to the significance of this issue. The Committee was aware that this issue was being addressed by the Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River (the Cohen Commission). Therefore, the Committee has chosen not to draw conclusions on these scientific questions and instead refers readers to the final report of the Commission.[33]

In the Standing Committee on Fisheries and Oceans' 2003 report on the *Federal Role in Aquaculture in Canada*, a significant portion was devoted to the management of environmental effects of aquaculture.[34] While not the focus of this report, the Committee notes that a number of recommendations made in the 2003 report have been implemented. For example, DFO's initial regulatory proposal to develop the regulations for fish pathogens and pest treatment (in order to clearly establish which substances such as pesticides and drugs can be used at aquaculture sites) has recently been revised to include the regulation of settleable solids, sulphide levels, and biological oxygen demand matter related to aquaculture activities.[35] Other recommendations from that report have not been implemented, including those related to monitoring for escapes and waste deposition from salmon farms.

Also, the Committee was told that since 2003, a number of other important changes have been made to environmental management regimes, including the relocation of some poorly sited farms, new farm siting requirements, and the adjustment of stocking, harvesting and sea lice treatment schedules in order to account for wild salmon migration seasons.[36] However, much scientific research remains to be carried out, and made publicly available, in order to instill greater public confidence in the environmental management of the aquaculture industry and to move the debate forward in identifying areas where improvement is needed.

The quantity and quality of information necessary for analyzing and managing the risks of net pen aquaculture was the subject of much discussion. Assessing the impact of

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33 See Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River, *Final Report*, 2012, http://www.cohencommission.ca/en/FinalReport/.

34 House of Commons Standing Committee on Fisheries and Oceans, *The Federal Role in Aquaculture in Canada, Ottawa*, April 2003, p. 33-59.

35 Fisheries and Oceans Canada, *A Proposed Regulatory Regime to Manage the Release of Aquaculture Substances*, February 2012.

36 For example: Eric Hobson, President, SOS Marine Conservation Foundation, Committee *Evidence*, November 22, 2011.

aquaculture facilities requires knowing the baseline conditions and monitoring change. Inadequate baseline knowledge was thought by one witness to be a significant limitation.[37]

Regarding sea lice and disease one witness felt that more research was needed on the long-term impact of disease and lice on external populations of fish[38] while another felt that there was enough known to inform a precautionary decision to prohibit net pen facilities in migration routes.[39] Still another thought that current monitoring was sufficient to establish that lice management was reducing infection rates both in raised and wild salmon, at least on the West Coast.[40]

The effects of net pen aquaculture on the benthic region were the subject of much discussion. In particular, the use of sulphide as a measure of benthic impact led to conflicting testimony as to whether or not recovery of benthic areas was adequate during fallow management. The Department presented that, depending on the site, the benthic region would fully recover in months to years with the required fallow being three months to a year.[41] However, the sulphide level technique for measuring recovery was criticized by a number of witnesses, one of whom called it "a bit crude and rudimentary."[42] Another suggested that full recovery of the biological community, habitat function and health had never been confirmed.[43] The level of recovery then depends on what is being measured and over what length of time. Further research on environmental impacts of net pen aquaculture will help clarify these issues.

It should be noted that environmental impacts are not unique to open-net pen aquaculture production; closed containment aquaculture carries its own set of environmental impacts which, given the state of the industry, are not yet well-studied. The carbon footprint generated by a closed containment facility drawing electricity, pumping in water, filtering waste, among other actions, is significant. The source of the electricity, for example, hydro-generated or coal-generated, would also play a major factor in the perceived sustainability of closed containment aquaculture. The Coastal Alliance for

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37 Dr. Colin Brauner, Department of Zoology, University of British Columbia, as an Individual, Committee *Evidence*, December 8, 2011.

38 David Lane, Executive Director, T. Buck Suzuki Environmental Foundation, Committee *Evidence*, November 17, 2011.

39 Dr. Lawrence Dill, Department of Biological Sciences, Simon Fraser University, Committee *Evidence*, May 12, 2010.

40 Canadian Aquaculture Industry Association, Brief.

41 Dr. Jay Parsons, Director, Aquaculture Science Branch, Department of Fisheries and Oceans, Committee *Evidence*, February 6, 2012.

42 Bill Robertson, Executive Director, Huntsman Marine Science Centre, Committee *Evidence*, February 13, 2012.

43 Inka Milewski, Science Advisor, Conservation Council of New Brunswick, Committee *Evidence*, November 29, 2011.

Aquaculture Reform states on their web site that closed containment systems do require more obvious direct energy than net cages, however, they feel that factors other than energy use must be considered to determine true sustainability.[44] One of the key action items identified by the Canadian Council of Fisheries & Aquaculture Ministers in their 2010 West Coast Marine Finfish Sector Strategic Action Plan was the need to quantify the carbon footprint, water quality impact, sediments, chemicals, antibiotics, pesticides, nutrient loading, escapes, disease, etc. of each of the aquaculture subsectors.[45]

Similarly, according to Andrew Wright, a full life-cycle analysis (covering a 25-year production span) must be conducted of both open-net pen aquaculture production and land-based RAS. In particular, he noted, no accurate accounting has been done to measure the methane releases caused by the decomposition of the wastes that accumulate on the ocean floor beneath open net salmon farms. According to his estimates, however, if these methane emissions are accounted for, the carbon dioxide equivalent (CO_2e) emissions of an open-net pen salmon farm likely overshadow the CO_2e emissions of a land-based RAS of equivalent annual production capacity by a factor of 10. Dr. Wright urged the Committee to recommend that this research be conducted to accurately assess and compare the different salmon aquaculture production methods.[46]

C. Improved Socio-Economic Outcomes

The aquaculture industry (for all species, not just salmon) is estimated to provide 4900 direct, full-time equivalent jobs across Canada[47] and pays out approximately $106.2 million in salaries and wages each year.[48] Indirect and induced activities are estimated to generate a further 9600 full-time equivalent jobs.[49]

The Committee heard from a number of coastal communities where aquaculture development has taken place. While some were in favour of open-net pen aquaculture and others were opposed, it was mentioned that the main jobs generated by aquaculture in rural areas centered around transportation and support work, while positions in processing plants remained in larger centres. Depending on the organization and their

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44 Kelly Roebuck, SeaChoice, Committee *Evidence*, December 6, 2011, in reference to material on the Coastal Alliance for Aquaculture Reform's Web site; *Aquaculture, Closed Containment Technologies and Energy Consumption Backgrounder*.

45 Canadian Council of Fisheries & Aquaculture Ministers, *National Aquaculture Strategic Action Plan Initiative, 2011-2015: West Coast Marine Finfish Sector Strategic Action Plan*, December 16, 2010, p. 13.

46 Andrew Wright, Committee *Evidence*, and PowerPoint Presentation, November 17, 2011.

47 Department of Fisheries and Oceans, Socio-Economic Impact of Aquaculture in Canada, 2010, p. 18.

48 Statistics Canada, Aquaculture Statistics, Catalogue No. 23-222-X, 2010, p. 22.

49 Department of Fisheries and Oceans, Socio-Economic Impact of Aquaculture in Canada, 2010, p. 18.

hiring practices, the farm site could employ workers who commute from larger centres as well.[50]

The possible impact of closed-containment aquaculture on coastal employment was discussed. Witnesses pointed out that mandating closed containment and banning net pen aquaculture without closed containment being economically viable could have a drastic effect on employment.[51] Witnesses noted that, technically, RAS closed containment salmon aquaculture could take place anywhere, including inland. In order to be competitive in the international marketplace, producers could be inclined to locate their operations where input costs were the lowest (such as energy, transportation, water and land costs). If inland locations were economically more attractive, and companies were to relocate, there could be a serious negative impact on employment in remote coastal regions that currently rely on net pen for employment. Whatever actions the government takes regarding closed containment aquaculture, employment impacts in coastal communities must be a foremost consideration. In many of these coastal communities, aquaculture can provide much needed employment opportunities. Gerry Furney, mayor of Port McNeill, noted that his community depends on resource industries like open-net pen aquaculture.[52]

> Aquaculture is an ideal way in which to employ people who wish to work in isolated communities…Closed containment, with the huge capital investment that it requires, could not be justified in these isolated areas.[53]

While other witnesses noted that, in their view, there are some factors that might influence the industry to remain in coastal areas (availability of water and existing infrastructure for example)[54] the Committee remains concerned about the implications of closed containment technology for coastal employment and believes that the Government of Canada must carefully consider those impacts when making further decisions affecting the industry and stakeholders.

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50 Neil Smith, Manager, Town of Port McNeill, Committee *Evidence*, February 29, 2012; and Brenda Patterson, Member, St. Mary's Bay Coastal Alliance, Committee *Evidence*, February 15, 2012.

51 Ruth Salmon, Committee *Evidence*, November 1, 2011.

52 Gerry Furney, Mayor, Town of Port McNeill, Committee *Evidence*, February 29, 2012.

53 Ibid.

54 Catherine Stewart, Campaign Manager, Living Oceans Society, Committee *Evidence*, December 8, 2011; Catherine Emrick, Senior Associate, Tides Canada Foundation, Committee *Evidence*, November 24, 2011; and David Lane, Committee *Evidence*, November 17, 2011.

Recommendation 1

The Committee recommends that the Government of Canada study the socio-economic impacts of a possible transition to closed containment technologies, including the resulting impacts on employment in rural and coastal communities.

Decisions on aquaculture might also have implications for employment in other fisheries. As already noted in this report, there was considerable discussion about the environmental impacts of net pen aquaculture. Some witnesses based their opposition to net pen aquaculture, and by association their support for closed containment, on how these environmental impacts might jeopardize traditional industries. On the West Coast, concerns were raised about risks to the large recreational fishery. On the East Coast, some commercial fishermen in Nova Scotia were concerned about how the expansion of open-net pen salmon aquaculture might affect the lobster fishery in their area.[55] While many factors may influence lobster landings it was noted on questioning of a high-level DFO official that, in general, lobster landings in the Bay of Fundy have been "very good."[56] Given the inconclusive nature of the evidence regarding the environmental impacts, it is not possible to determine the actual risks posed by net pen aquaculture to traditional fisheries, but this does not diminish the concern felt by those involved in those industries. The Committee appreciates these concerns and understands how seriously any threat to traditional economic activities must be taken, especially in areas where, often, few other economic opportunities exist.

The Committee is confident that, as the nature of environmental impacts is better understood, proper siting, adequate environmental regulations and the selection of the appropriate aquaculture technology (including land-based RASs) will allow the coexistence of the aquaculture industry with traditional fisheries.

The Committee heard varying opinions from First Nations witnesses regarding net pen aquaculture. Some First Nations communities have embraced aquaculture and now work with industry to ensure that open-net pen aquaculture developments respect their social and cultural values and interests, and that the First Nation benefits economically from the project.[57] Other First Nations communities however, remain opposed to net pen salmon aquaculture near their communities and traditional territories due to concerns about potential negative impacts to wild fisheries and traditional clam beds.[58]

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55 St. Mary's Bay Coastal Alliance, Committee *Evidence*, February 15, 2011.

56 Kevin Stringer, Assistant Deputy Minister, Department of Fisheries and Oceans, Committee *Evidence*, October 27, 2011.

57 Gerry Furney, Committee *Evidence*, February 29, 2012.

58 William Cranmer, Chief, 'Namgis First Nation, Committee *Evidence*, November 22, 2011.

Richard Harry, of the Aboriginal Aquaculture Association, explained that while First Nations have many concerns regarding open-net pen aquaculture, essentially they are concerned that the industry operates sustainably, wild fisheries are not negatively impacted, communities benefit and First Nations are actively engaged in shared decision-making regarding aquaculture developments. As he explained to the Committee:

> We need to take seriously that our coastal communities are there. First Nations people are not going to leave; we're going to be there into the future. We're looking to find the ways and means to develop a process, to develop an aquaculture industry that is sustainable, both environmentally as well as culturally.[59]

With respect to closed containment aquaculture, First Nations have been among some of the first interested in developing this technology. As described above, the first commercial scale RAS Atlantic salmon operation in Canada is currently being constructed by the 'Namgis First Nation. The Committee was also told that other First Nations were in the process of assessing the potential of closed containment for their own communities.[60] Many of the consultants and researchers involved in these early closed containment projects also pointed out that First Nations communities are often ideally suited to closed containment due to their geographical location, access to land and water, cultural values and history and experience in the fishery.

The Committee recognizes that aquaculture could represent a significant opportunity for many First Nations communities and supports efforts to make sustainable aquaculture projects accessible to First Nations who might be interested in pursuing them. As stated by Daniel Stechey:

> Throughout this country we have a crying need to create economic development for aboriginal communities. If there is one industry that works in rural aboriginal communities where there is the resource base to develop an industry, it is aquaculture. Be it with finfish, be it with shellfish, be it coastal, be it inland, there's a tremendous opportunity there. They do not have the capacity to engage in aquaculture, and that's something that needs to be addressed. This is a huge opportunity that this country is missing.[61]

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59 Richard Harry, President, Aboriginal Aquaculture Association, Committee *Evidence*, October 28, 2010.

60 Catherine Emrick, Committee *Evidence*, November 24, 2011.

61 Daniel Stechey, Committee *Evidence*, November 1, 2011.

Recommendation 2

The Committee recommends that the Government of Canada continue to work with rural, coastal and First Nations communities to encourage economic growth through the development of aquaculture operations, including the use of closed containment technologies.

Ultimately, the Committee understands that the aquaculture industry can be an important contributor to rural and coastal economies, and supports its existence and expansion in the form suitable to each particular location, whether this be open-net pen, closed containment, or any of the other innovative aquaculture technologies currently under development, if proven economically viable. As Neil Smith of Port McNeill stated:

> We're not dealing with an either-or situation. The north island is very well positioned to maintain open-pen operations. We also need to look at closed containment technologies and their potential for niche sectors in domestic and international markets... I think a number of different applications are possible, and anything that assists the region in diversifying its aquaculture is to the region's strength. A diverse rural economy is a strong rural economy, even within one sub-sector like aquaculture. From a regional perspective, it's a good-news story to be exploring all these options without throwing anything out.[62]

THE ECONOMICS OF CLOSED CONTAINMENT AQUACULTURE

> But aquaculture is a business, and at the end of the day, we're growing fish to make money.[63]

A. The Viability of Closed Containment Atlantic Salmon Aquaculture

Very early in the Committee's study, it became clear that closed containment technologies are well-developed and have been used for decades for a number of different species of fish. The debate is no longer centered on whether or not it is technically possible to raise Atlantic salmon in closed containment operations; it is, rather, whether or not this can be done at a cost that will allow closed containment Atlantic salmon producers to be competitive with open-net pen salmon producers. As stated by Colin Brauner from the University of British Columbia:

> Land-based closed containment aquaculture is technically possible, but its economic feasibility is a topic of debate. What is clear is that profitability is dependent on optimizing water quality and the biological conditions for growth of salmon at high densities. Recirculating aquaculture systems, abbreviated RAS, are unique in aquaculture in that they provide an opportunity to completely control the environmental rearing conditions, such as salinity, temperature, ammonia, carbon dioxide, and density, all of which can

62 Neil Smith, Committee *Evidence*, February 29, 2012.

63 Daniel Stechey, Committee *Evidence*, November 1, 2011.

> greatly influence growth. Complete control over these conditions allows salmon to be reared under optimal conditions, promoting fish welfare and product quality, maximizing growth and economy of production.[64]

Compared to open-net pen Atlantic salmon farming, a land-based RAS is a relatively high-tech and high-cost endeavour. To offset these additional costs, however, RAS offer a number of potential advantages, including faster growth rates, and the potential to stock salmon at three to seven times the density possible in conventional net pens. For example, the Committee heard that whereas the density of biomass at open-net pen Atlantic salmon aquaculture sites tends to be approximately 15 kg/m^3,[65] the density possible in RAS (due to increased control over water quality and oxygenation) ranges from 50 to 80 kg/m^3,[66] though could be as high as 100 kg/m^3.[67] Research is still ongoing at the University of British Columbia, research centres such as the Freshwater Institute in West Virginia, and through pilot projects such as the one currently being built by the 'Namgis First Nation, in order to determine what these optimal growing conditions and maximum densities are.

As these parameters are refined, and economic uncertainties are reduced, closed containment could become increasingly competitive with open-net pen aquaculture. As it was explained to the Committee, competitiveness with the open-net pen aquaculture industry matters because Atlantic salmon is a global commodity product. As Daniel Stechey said:

> I'd just like to make it really clear that in my opinion — and there are many examples of this — closed containment is economically viable today. We have coho farms that are producing coho and selling into a niche market. We've got tilapia farms that have been growing fish in closed containment systems and selling to live markets in Vancouver, Toronto, Montreal, and New York City for 15 to 20 years already. These are closed containment systems. They work.
>
> The thing that sets them apart is that they're producing a premium priced product, so you can afford the technology… When you go to a commodity product like Atlantic salmon and you're competing with producers around the world who are using a lower-cost technology to produce it, that is, net pens, then you're going to have a hard time competing unless you become extremely large scale with very high capital costs.[68]

Coho salmon, the Committee was told, is produced at a cost of $1.97 per pound ($4.3 per kg) in the relatively small land-based RAS in Montana and Agassiz, BC. With a

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64 Colin Brauner, Committee *Evidence*, December 8, 2011.

65 Alistair Struthers, Team Leader, Innovation, Aquaculture Management Directorate, Fisheries and Oceans, Committee *Evidence*, February 6, 2012.

66 Eric Hobson, Committee *Evidence*, November 22, 2011.

67 Dr. Steven Summerfelt, The Freshwater Institute, Slide presentation during Committee trip, March 6-8, 2012.

68 Daniel Stechey, Committee *Evidence*, November 1, 2011.

selling price of $3.50 to $4.00 per pound ($7.7 to $8.8 per kg), this provides a healthy profit margin.[69] Atlantic salmon, on the other hand, has experienced market lows, recently selling for $2.30 to $2.60 per pound ($5.1 to $5.7 per kg), which significantly reduces the potential profit margin if the costs of the production are the same as they are in the existing small-scale closed containment units for coho. Many believe, however, that at a larger scale, the cost of production can be significantly lower. But, without a commercial-scale closed containment Atlantic salmon aquaculture facility in operation, the debate surrounding the economic feasibility of these systems relies heavily on models, which in turn rely on a number of assumptions. Two of these economic feasibility studies (as well as the variables that produce the greatest discrepancies) are discussed below.

B. Economic Feasibility Studies and Key Variables

Two economic feasibility studies were published in 2010, one by DFO[70] and one by Andrew Wright,[71] both of which demonstrate that at least under certain circumstances, closed containment could show positive returns. Beyond this, however, different assumptions produced very different results.

In DFO's feasibility study, a preliminary assessment of several different types of aquaculture facilities was conducted. These facilities included conventional open net systems, ocean-based closed containment systems with rigid walls, ocean-based closed containment systems with flexible walls, land-based flow-through systems, and land-based recirculating systems.

DFO's feasibility study demonstrated that a 2,500 tonnes (annual production capacity) RAS would require an initial capital investment of $22.6 million and annual operating costs of $7.2 million in order to generate an annual net profit of $381,467. This corresponds to a rate of return of 3.4%. By way of comparison, the study demonstrated that a similar capacity open net aquaculture operation would require an initial capital investment of only $5 million and would generate an annual net profit of $2.6 million (for an expected rate of return of 40.3%).

Dr. Wright's analysis, on the other hand, suggests that a land-based RAS could be significantly more profitable than the DFO analysis concludes. It should be noted at the outset that the figures presented in the two analyses are not directly comparable since the DFO study was based on a 2,500 tonnes annual production capacity, whereas Dr. Wright's was based on a 1,000 tonnes annual production capacity. In any case, even

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69 John Holder, Committee *Evidence*, November 24, 2011.

70 D. Boulet, A. Struthers and E. Gilbert, Fisheries and Oceans Canada, *Feasibility Study of Closed-Containment Options for the British Columbia Aquaculture Industry*, September 2010.

71 A. Wright and N. Arianpoo, *Technologies for Viable Salmon Aquaculture: An Examination of Land-Based Closed Containment Aquaculture*, May 2010.

with this smaller size (and, more conservative figures for a number of variables), Dr. Wright's analysis resulted in required capital costs of approximately $12 million for a net annual income of at least $5.1 million (or up to $8.2 million if one factors in a 25% premium that the fish may be able to generate if they are marketed as sustainable and chemical-free). In addition, net annual income would climb to between $9 and $13.1 million if the waste stream is utilized for aquaponics and compost. These assumptions relating to possible revenue from the capture and sale of the waste stream were supported by Steven Summerfelt of the Freshwater Institute, who told the Committee of a 1000 tonnes closed containment facility currently producing another type of fish that is generating $250,000 per year solely by selling its waste as fertilizer.

Dr. Summerfelt also shared his own economic analysis with the Committee. He highlighted the need for access to inexpensive land close to markets and low electricity costs, in the range from $0.02-$0.06/kWh. Given these two conditions, he concluded that a 1000 tonnes land-based RAS would be able to operate at a profit, even without factoring in a price premium that many predict could be obtained for closed containment salmon. At a 3000 tonnes production capacity, he concluded that a land-based RAS would not only be profitable, but would be competitive with open-net pen production in North America.[72]

The Committee notes that any conclusion about economic feasibility is based on assumptions and variables relating to market price, utilization of the waste stream, optimal densities, energy costs and costs relating to depreciation and interest on loans.

Some witnesses also pointed out that current costs of net pen production are only so low because a number of costs are not factored in, what are often called externalities. Eric Hobson of SOS Marine Conservation Foundation, for example, expressed his desire to see the development of a regulatory regime for net pen aquaculture that requires industry to bear the full costs of net pen production methods, including externalities such as the monitoring of impacts on the marine environment. This, he suggested, would level the playing field for new technologies such as closed containment.[73]

As also noted by the Living Oceans Society, the externalities of open-net pen aquaculture production can also include the costs to government associated with the industry:

> Closed containment operators are by and large internalizing those costs. If we switch to closed containment, DFO is not going to have to deal with escapes, with sea lice and disease transfer to wild salmon, predator deaths, waste deposition in the marine environment, and toxic residues. The moneys currently allocated for that, with the kind of enforcement and monitoring and public relations that are required, could be transferred to

72 Steven Summerfelt, Slide presentation during Committee trip, March 6-8, 2012.

73 Eric Hobson, Committee *Evidence*, November 22, 2011.

> supporting the development of a new and innovative industry, particularly the development of a product that the marketplace is increasingly demanding.[74]

While the Committee acknowledges the concerns of witnesses it is not in a position to say whether all of the externalities cited by witnesses necessarily have the environmental, social or economic costs that have been ascribed to them or whether it would be fair to assign those costs to the industry.

C. Marketing of Closed Containment Salmon

With respect to the market price variable, the Committee received input on three general themes: price premiums, consumer and retailer demand, and branding mechanisms, such as labelling and certification programs.

The Committee was told that the closed containment coho salmon producers in British Columbia and Washington are currently obtaining a significant price premium for their product by virtue of their ability to market it as an environmentally sustainable product. While witnesses had different views on the extent to which closed containment raised Atlantic salmon would be able to command a similar price premium, most witnesses agreed that, at least initially, it would be reasonable to expect that such a premium likely would exist, in much the same way it does for other products marketed as environmentally friendly. Andrew Wright, for example, told the Committee that the 'Namgis project has secured direct-to-marketplace contracts with grocers that verify the existence of the price premiums in the range of 25 to 30%.[75] As the closed containment industry grows, however, and closed containment-raised salmon becomes commoditized, some witnesses suspected that these price premiums would evaporate or diminish.

In addition to a “sustainability” price premium the Committee was told that closed containment Atlantic salmon may also be able to command a price premium due to both the quality and taste of the product, as well as potential health benefits resulting from the controlled environment and high water quality in which it is grown.[76]

On the subject of consumer and retailer demand, the Committee heard that a number of grocers across North America have developed or are developing sustainable seafood policies, which could potentially have the effect of reducing their purchases of net pen-produced salmon. The Committee heard from the Overwaitea Food Group, for example, about how they are reducing the amount of net pen reared salmon available in their stores and have attempted to fill this gap with as much closed-containment reared

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74 Catherine Stewart, Committee *Evidence*, December 8, 2011.

75 Andrew Wright, Committee *Evidence*, November 17, 2011.

76 Eric Hobson, Committee *Evidence*, November 22, 2011; and Andrew Wright, Committee *Evidence*, November 17, 2011.

coho salmon as can be made available to them. As this product is not currently available from Canadian producers in sufficient quantities, Overwaitea has signed an agreement with AquaSeed in Washington State for the supply of their SweetSpring salmon.[77] According to Overwaitea's experiences selling closed containment coho salmon, there is high customer demand for this product; demand for net pen farmed salmon has diminished to the point where stores will no longer be stocking it, and overall salmon sales "have never been better."[78]

Albion Fisheries, the largest seafood distributor in Western Canada stated that while they still stock and sell significant quantities of net-pen farmed salmon, indeed, their Vice-President and Chief Sustainability Officer Guy Dean indicated that it is their number one selling product and that he believes it can be farmed sustainably,[79] the company expressed strong support for closed containment salmon:

> We believe that closed containment is a more viable option and provides far better food safety… We think it is a more viable option, from an environmental perspective, so we are strongly putting our support behind closed recirculated aquaculture systems.[80]

Various ideas were brought forward related to branding opportunities that closed containment salmon might offer and that could generate marketing advantages and possible price premiums. Catherine Stewart of the Living Oceans Society thought that First Nations-produced closed containment salmon could gain a marketing boost through a First Nations brand.[81] Steven Summerfelt, thought that Canada should consider marketing supports such as a branding program similar to Canada's "VQA" program for quality wine.[82]

Finally, a number of witnesses, including Dr. Summerfelt, suggested that closed containment salmon could benefit from being labelled as “sustainable” by organizations that promote ranking systems to raise consumer awareness about the source and sustainability of fish and seafood products. For example, AquaSeed’s SweetSpring closed containment raised Pacific salmon have received SeaChoice’s “supergreen” rating for sustainable seafood. While many witnesses viewed these branding systems as a positive development, others were of the opinion that their proliferation could confuse or mislead consumers.

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77 Blendle Scott, Vice-President, Innovation and Supply Chain, Overwaitea Food Group, Committee *Evidence*, December 6, 2011.

78 Ibid.

79 Guy Dean, Vice-President, Import and Export, Albion Fisheries Ltd., Committee *Evidence*, December 6, 2011.

80 Ibid.

81 Catherine Stewart, Committee *Evidence*, December 8, 2011.

82 Steven Summerfelt, Follow-up communication to Committee, March 21, 2012.

In conclusion, because of growing consumer demand for a product that could command a price premium, as reported by witnesses, there is increasing optimism about the feasibility of closed containment Atlantic salmon production. The optimism, however, is primarily based on models which have yet to be fully tested at a commercially viable scale. The Committee looks forward to that being done in the pilot projects mentioned above.

INVESTMENTS IN CLOSED CONTAINMENT AQUACULTURE

The Committee heard extensive evidence on issues related to research and development (R&D), funding programs, and incentives required to help jumpstart the closed containment aquaculture industry. This evidence revolved around four main themes: the need for applied scientific research and facilities; the need for government support for demonstration projects; access to capital for private sector participants willing to be first-movers; and, the urgent need for all of these elements to be in place in the near future in order for Canada to benefit and retain its position as a major world producer of farmed salmon.

A. Research and Development

While there is a need for more basic scientific research, as discussed above in the context of potential environmental benefits of closed containment systems for aquaculture production, the Committee also heard that increased funding for applied science is critically important. Indeed, investing in research and development to advance closed containment aquaculture systems was one of the key action items identified by the Canadian Council of Fisheries & Aquaculture Ministers in their 2010 West Coast Marine Finfish Sector Strategic Action Plan.[83]

Applied aquaculture research would address questions related to such things as water chemistry, temperature, oxygenation and salinity for optimal fish health and growth; maximum biomass densities; and feed composition. Research into factors such as these can contribute to enhancing the economic performance and competitiveness of closed containment salmon aquaculture. According to Colin Brauner:

> A source of funding specifically geared to closed containment aquaculture would greatly enhance the rate at which information can be generated and disseminated to industry to increase Canada's competitiveness in the marketplace for the emerging technology of land-based closed containment aquaculture.[84]

Dr. Summerfelt also stressed the need for funding to support applied research and the dissemination of the results of that research. To this end, he encouraged

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83 Canadian Council of Fisheries & Aquaculture Ministers, *National Aquaculture Strategic Action Plan Initiative, 2011-2015: West Coast Marine Finfish Sector Strategic Action Plan*, December 16, 2010, p. 13.

84 Colin Brauner, Committee *Evidence*, December 8, 2011.

the Committee to support research at the InSEAS facility at the University of British Columbia.

While visiting the Freshwater Institute in West Virginia, the Committee was told that the US (primarily through the United States Department of Agriculture (USDA) and the National Oceanic and Atmospheric Administration (NOAA)) provides approximately $80 million per year exclusively for aquaculture research. Staff of the USDA and NOAA echoed this, noting that the one comparative advantage the US presently has over Canada in terms of the expansion of the aquaculture industry is the significant amount of R&D funding available in the US. However, it was noted that there had been no commitment for the renewal of that funding.[85]

In addition to applied research carried out at dedicated research facilities and academic institutions, it was also noted that the industry has a role in carrying out this research as well, and that appropriate incentives should therefore be considered to support industry research and development of new technologies to increase water reuse, reduce the energy costs and create value from RAS waste streams.[86] According to Marine Harvest Canada, a lack of funding is the most significant obstacle to the development and growth of closed containment in Canada.[87]

It was suggested to the Committee that Norway's NOFIMA (Europe's largest institute for applied research in fisheries, aquaculture and food production) provides one model that Canada could consider adopting in order to pursue applied research in land-based closed containment systems for salmon farming.[88] The Norway Ministry of Fisheries and Coastal Affairs is the majority shareholder of NOFIMA, with industry representing the remainder; it has a mandate to carry out research in furtherance of public policy, as well as contract-based research for commercial enterprises. The Committee notes that such an approach would also be consistent with one of the primary recommendations made in the Jenkins Report last fall on how to improve innovation in Canada.[89]

B. Demonstration Projects

The Committee heard from DFO, SDTC, and almost unanimously from other stakeholders, that closed containment systems have proceeded far enough along the

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85 Steven Summerfelt, Comments to the Committee, March 6-8, 2012.

86 Steven Summerfelt, Follow-up communication to Committee, March 21, 2012.

87 Clare Backman, Committee *Evidence*, November 1, 2011.

88 Steven Summerfelt, Follow-up communication to Committee, March 8, 2012.

89 Jenkins Report, *Innovation Canada: A Call to Action*, Review of Federal Support to Research and Development — Expert Panel Report, October 2011 (Recommendation 4).

innovation chain that government funding of commercial-scale demonstration projects is now necessary before full commercial deployment can be expected by the private sector. As explained by Maria Aubrey of SDTC:

> While these technologies offer promising environmental and economic returns, this can only be proven through demonstrations in real-life settings. The reality is that industry and private investors consider these types of early stage investments to be too risky, with uncertain economic returns; however, if the economic viability of these technologies is demonstrated, they are quite willing to invest in the deployment of these technologies. Public funding through SDTC, in partnership with industry, helps to fill this gap and gives Canada a leadership position in closed containment.[90]

According to Ms. Aubrey, SDTC has received seven salmon aquaculture-related applications over the past six years, but has only committed to funding two of these (AgriMarine's Middle Bay project and the 'Namgis First Nation's project), for a total contribution of $8.2 million.

While the Committee supports the important contributions made by SDTC, a number of witnesses commented that the amount of funding available is insufficient and that application and reporting requirements are too onerous (and oftentimes not consistent with the application and reporting requirements of other funding organizations). Marine Harvest Canada, for example, applied for funding through SDTC and DFO in order to pursue their planned closed containment demonstration project, but the funding approved was insufficient to allow the project to proceed. According to Clare Backman of Marine Harvest:

> In a general sense, as has been mentioned, I think at this point in time the federal government should be supportive of these programs that are going to allow us to come to terms with the real costs and benefits of these newer technologies, so we can get past the discussion about whether it's all or nothing and find out exactly where it fits into the marketplace and the overall plan for salmon going forward.[91]

Recommendation 3

The Committee recognizes the important contributions made by Sustainable Development Technology Canada (SDTC) and recommends that the Government of Canada work with SDTC to ensure that its application and reporting requirements facilitate the funding of research and development of sustainable closed containment technologies.

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90 Maria Aubrey, Senior Vice-President, Operations, Sustainable Development Technology Canada, Committee *Evidence*, November 24, 2011.

91 Clare Backman, Committee *Evidence*, November 1, 2011.

The need for funding to support pilot and demonstration projects was also stressed by Dr. Summerfelt of the Freshwater Institute. To this end, he encouraged the Committee to continue supporting the 'Namgis closed containment pilot as it scales up in size, as well as to consider establishing a similar pilot in Atlantic Canada at 300–1000 tonnes capacity, as a public-private partnership in order to evaluate the economics of production at commercial scale and catalyze the economic opportunity associated with such projects on the East Coast.[92]

Mr. Robertson of the Huntsman Marine Science Centre in St. Andrews, New Brunswick suggested that the federal government could set up a commercial-scale land-based RAS facility at the Huntsman Centre's facilities in order to obtain the real-time data necessary to compare closed containment production against open-net pen production, to conduct research and development, and to focus on continuous development.[93]

The Committee recognizes the important role that government funding must play in certain circumstances in order to allow promising technologies to proceed along the innovation chain that might otherwise stall or take significantly longer to reach full commercialization. The Committee believes that closed containment aquaculture systems may be one of these technologies.

The Committee also heard, however, from a number of other aquaculture researchers and entrepreneurs who are pursuing other solutions (including integrated multi-trophic aquaculture and small-scale open ocean aquaculture) to some of the challenges associated with traditional net pen aquaculture.[94] The Committee believes that there is likely a suite of different technologies and approaches that may allow salmon aquaculture to be more sustainable. With this in mind the Committee feels strongly that any government funding programs should support all forms of promising innovation, in all aquaculture technologies.

C. Access to Capital

The capital investment required to build closed containment aquaculture systems can be quite high. The Committee heard that the capital costs have ranged from about one million dollars for the 160 tonnes facilities in Montana,[95] to $6 or 7 million for the

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92 Steven Summerfelt, Follow-up communication to Committee, March 8, 2012 and March 21, 2012.

93 Bill Robertson, Committee *Evidence*, February 13, 2012.

94 Dr. Thierry Chopin, Scientific Director, Canadian Integrated Multi-Trophic Aquaculture Network and Andrew Storey, President and Chief Executive Officer, Open Ocean Systems Inc., Committee *Evidence*, February 13, 2012.

95 John Holder, Committee *Evidence*, November 24, 2011.

400 tonnes to 500 tonnes facility being built for the 'Namgis First Nation,[96] to just under $10 million for the 1000 tonnes Langsand Laks system being built in Denmark.[97] As explained by John Holder, one of the leading consultants involved in the design of these systems, this is a significant issue:

> The big thing, of course is capital. In the past, these ventures were quite expensive. You're looking at $12 or $13 per kilo of production. Now we're down to $8.50. If you do the financials on that, your return on investment is over 30% with a 5% depreciation. You can do even better than that with other cost-saving devices that we're still in the research stage on. Still, $8.5 million [for a 1000 tonnes facility] is a lot of money, and it's not for people who do not have that type of ability to raise that capital.[98]

According to several witnesses, access to capital has been a significant barrier to more widespread development of closed containment aquaculture. In order to remedy this particular gap, witnesses proposed a variety of measures, including government loans,[99] incentive programs for private investors willing to scale up from pilot to commercial-scale,[100] and loan guarantees. As noted by Mr. Holder:

> Getting the banks to lend private individuals money is next to impossible. Also, the process of applying for grants is onerous and the success rate is not that high. For us to expand this business to the mom-and-pop shops — that's the name I give it — they need provincial or federal help — loan guarantees or whatever — because the banks do not lend money for aquaculture ventures. Community Futures has lent money in the past, but when they start paying it back it ends up that the interest rates are very onerous. It's tough for the small entrepreneur to get into this market.[101]

The Committee acknowledges the concerns relating to access to capital and notes that the Jenkins Report also identified this as a gap in Canadian innovation more broadly. The Committee heard that some amount of dedicated funding may be required in the short term to allow closed containment technologies to gain more widespread use and acceptance.

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96 Andrew Wright, Committee *Evidence*, November 17, 2011.

97 Fisheries and Oceans Canada, Committee *Evidence*, October 27, 2011; and Andrew Wright, Committee *Evidence*, November 17, 2011.

98 John Holder, Committee *Evidence*, November 24, 2011.

99 David Lane, Committee *Evidence*, November 17, 2011.

100 Steven Summerfelt, Follow-up communication to Committee, March 21, 2012.

101 John Holder, Committee *Evidence*, November 24, 2011.

Recommendation 4

The Committee recognizes that any commercial adoption of closed containment aquaculture or other innovative aquaculture technologies will require public and private financial support to complete research and ultimately to allow promising new and viable technologies to advance from demonstration to commercialization. Therefore, the Committee recommends that the Government of Canada, in conjunction with industry, review the financing options to ensure that resources are available to close the commercialization gaps. The Committee further recommends that the government-industry review considers a dedicated fund for closed containment demonstration projects.

D. Retaining Canada's Competitive Advantage

As pointed out by a number of witnesses, Canada currently enjoys a competitive advantage in salmon aquaculture production due to geography, existing expertise, infrastructure, processing facilities, sources for salmon feed and other inputs, proximity to the US market and a marketing advantage that derives from Canada's image as wild, northern and pristine. A number of other characteristics suggest that Canada could continue to enjoy a competitive advantage in closed containment salmon production, by virtue of large amounts of land, water, and, in some provinces, inexpensive hydro-electricity. Andrew Wright pointed out, however, that this competitive advantage is not guaranteed:

> British Columbia is privileged with a huge number of first-mover advantages... Those advantages are not permanent. Entrepreneurs closer to market will develop competitive solutions, and we are beginning to see this in Denmark with their first farm, Atlantic Sapphire, coming online this last summer.[102]

The Committee heard that large-scale (1000 tonnes to 3000 tonnes) commercial RAS are already under construction or in various preparatory stages in Denmark, Chile and on the East Coast of the US.[103] The largest project currently under construction in Canada, on the other hand, is the 'Namgis project at 400 tonnes to 500 tonnes capacity (although this project is designed to be able to scale-up at a later time). As stated by Dr. Summerfelt:

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102 Andrew Wright, Committee *Evidence*, November 17, 2011.

103 Steven Summerfelt, Follow-up communication to Committee, April 23. 2012.

> I think that we are on the verge of a large expansion into land-based closed containment systems. Now would be a good time for Canada to invest in land-based closed containment system technology to stay globally competitive.[104]

The Committee believes that Canada is well-positioned to take advantage of current technological developments and market trends and with the necessary policies and funding programs in place Canada could capitalize on our competitive advantages and reinforce our position as a world leader in sustainable salmon aquaculture production.

THE REGULATORY FRAMEWORK FOR AQUACULTURE

In its 2003 report, *The Federal Role in Aquaculture in Canada*, the Committee noted that "the clarification of the respective legislative responsibilities and obligations of the two senior levels of government is of utmost importance."[105] At the time of that report, in eight provinces and territories the responsibilities of the federal and provincial governments with respect to aquaculture were set out in a series of Memoranda of Understanding (MOUs). More recently, in a 2009 decision of the B.C. Supreme Court,[106] Justice Hinkson ruled that the federal government is responsible for management and protection of fisheries and ordered an end to B.C.'s regulation of ocean-based finfish aquaculture. Accordingly, the federal government has now developed the *Pacific Aquaculture Regulations*, under the *Fisheries Act*, and assumed the primary role in the management of aquaculture off the West coast.

Industry representatives observed that the complex legislative and regulatory environment, which varies from province to province, hinders the growth of the aquaculture industry.[107] They were of the opinion that an adequate framework cannot be provided by the *Fisheries Act* and, in order to address this issue, as well as a number of others, many witnesses recommended that the federal government develop an aquaculture act. The Committee notes that this was also a recommendation made in the Committee's 2003 report on aquaculture.[108]

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104 Ibid.

105 House of Commons Standing Committee on Fisheries and Oceans, *The Federal Role in Aquaculture in Canada, Ottawa*, April 2003, p. 26.

106 *Morton v. British Columbia* (Agriculture and Lands), 2009 BCSC 136.

107 Clare Backman, Committee *Evidence*, November 1, 2011.

108 House of Commons Standing Committee on Fisheries and Oceans, *The Federal Role in Aquaculture in Canada*, Ottawa, April 2003, p. 20-22.

Recommendation 5

The Committee recommends that the Government of Canada develop a national policy and regulatory framework for aquaculture including an aquaculture act.

Some witnesses made strong statements regarding the need for Canada to transition to closed containment aquaculture. Industry was unequivocal that a legislated transition to closed containment could be extremely detrimental to the Canadian aquaculture industry, For example, Ruth Salmon, Executive Director of the Canadian Aquaculture Industry Alliance said:

> If that were mandated, the industry, realistically, might not even be able to survive. The industry would look at operations elsewhere if that were mandated. It could have a dramatic effect... But we also might not have an industry, because it would be physically impossible to move 40,000 metric tons of marine harvest production on land.[109]

Even enthusiastic supporters of a full transition to closed containment aquaculture, while affirming the feasibility of such a transition, tended to estimate that this would take at least 10 years.[110]

CONCLUSION

During its study the Committee was exposed to many opinions and positions on the development of Atlantic salmon aquaculture in Canada. Presentations on technology, fish health, environmental concerns, socio-economic benefits and many more issues provided the Committee with an understanding that salmon aquaculture is an important and complex industry that provides Canada with a significant source of economic activity in rural communities and helps meet the world's demand for seafood protein that cannot be met by wild fisheries alone. Ruth Salmon expressed that "traditional capture fisheries are not going to be increasing in volume [and] to meet seafood demand in Canada, as well as internationally, [the product] has to come from aquaculture."[111] These comments were echoed by Bill Taylor who affirmed that "the whole concept of raising fish for food makes good sense and takes pressures off wild stocks."[112]

The Committee recognizes that salmon aquaculture is a relatively new industry to Canada, having developed since only the 1980s. The Committee witnessed an apparent coalescence of opinion amongst a broad and diverse group of stakeholders. Industry

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109 Ruth Salmon, Committee *Evidence*, November 1, 2011.

110 Eric Hobson, Committee *Evidence*, November 22, 2011.

111 Ruth Salmon, Committee *Evidence*, November 1, 2011.

112 Bill Taylor, President, Atlantic Salmon Federation, Committee *Evidence*, November 15, 2011.

representatives, for example, acknowledge that their activities have certain environmental impacts, while representatives of environmental groups acknowledge that the aquaculture industry has come a long way over the past decade in terms of its environmental management practices. The industry's future is strong with our competitive advantages and opportunities to diversify with supporting technology to provide strength to rural Canada. However, we still have much to learn.

Recommendation 6

The Committee recommends that the Government of Canada, supported by industry, establish a canadian centre of excellence for salmon aquaculture development at a university to study all aspects of salmon aquaculture development, including its impact on surrounding communities.

The Committee is optimistic that ongoing pilot projects will demonstrate the commercial viability of closed containment technology for salmon aquaculture. As one of a suite of different technologies, the Committee recognizes the potential for closed containment to contribute to the development of a thriving and sustainable aquaculture industry in Canada. The Committee understands the need for the right policies and programs to be in place for Canada to capitalize on its advantages and realize the full economic benefits of the aquaculture industry.

LIST OF RECOMMENDATIONS

Recommendation 1

The Committee recommends that the Government of Canada study the socio-economic impacts of a possible transition to closed containment technologies, including the resulting impacts on employment in rural and coastal communities. 16

Recommendation 2

The Committee recommends that the Government of Canada continue to work with rural, coastal and First Nations communities to encourage economic growth through the development of aquaculture operations, including the use of closed containment technologies. 18

Recommendation 3

The Committee recognizes the important contributions made by Sustainable Development Technology Canada (SDTC) and recommends that the Government of Canada work with SDTC to ensure that its application and reporting requirements facilitate the funding of research and development of sustainable closed containment technologies. 26

Recommendation 4

The Committee recognizes that any commercial adoption of closed containment aquaculture or other innovative aquaculture technologies will require public and private financial support to complete research and ultimately to allow promising new and viable technologies to advance from demonstration to commercialization. Therefore, the Committee recommends that the Government of Canada, in conjunction with industry, review the financing options to ensure that resources are available to close the commercialization gaps. The Committee further recommends that the government-industry review considers a dedicated fund for closed containment demonstration projects. 29

Recommendation 5

The Committee recommends that the Government of Canada develop a national policy and regulatory framework for aquaculture including an aquaculture act. 31

Recommendation 6

The Committee recommends that the Government of Canada, supported by industry, establish a canadian centre of excellence for salmon aquaculture development at a university to study all aspects of salmon aquaculture development, including its impact on surrounding communities. 32

APPENDIX A
LIST OF WITNESSES

First Session, 41st Parliament

Organizations and Individuals	Date	Meeting
Department of Fisheries and Oceans	2011/10/25	10
Eric Gilbert, Director, Innovation & Sector Strategies, Aquaculture Policies		
Jay Parsons, Director, Aquaculture Science Branch		
Alistair Struthers, Team Leader, Sector Strategies, Aquaculture Policy		
Department of Fisheries and Oceans	2011/10/27	11
Sharon Ford, Director, Stewardship, Aquaculture Management Directorate		
Jay Parsons, Director, Aquaculture Science Branch		
Stephen Stephen, Director, Biotechnology and Aquatic Animal Health Science		
Kevin Stringer, Assistant Deputy Minister, Program Policy		
Alistair Struthers, Team Leader, Sector Strategies, Aquaculture Policy		
Canadian Aquaculture Industry Alliance	2011/11/01	12
Ruth Salmon, Executive Director		
Canadian Aquaculture Systems Inc.		
Daniel Stechey, President		
Marine Harvest Canada		
Clare Backman, Director, Sustainability		
Atlantic Salmon Federation	2011/11/15	14
Jonathan Carr, Director, Research and Environment		
Bill Taylor, President		
Cooke Aquaculture Inc.		
Alan Craig, Vice-President, Sales, True North Salmon		
Nell Halse, Vice-President, Communications		

Organizations and Individuals	Date	Meeting
Gray Aqua Group Ltd.	2011/11/15	14
J. Terry Drost, Marketing, Four Links Marketing		
SOS Marine Conservation Foundation	2011/11/17	15
Andrew Wright, Technology Advisor		
T. Buck Suzuki Environmental Foundation		
David Lane, Executive Director		
'Namgis First Nation	2011/11/22	16
William T. Cranmer, Chief		
SOS Marine Conservation Foundation		
Eric Hobson, President		
JLH Consulting Inc.	2011/11/24	17
John Holder, President		
Sustainable Development Technology Canada		
Maria Aubrey, Senior Vice-President, Operations		
Keith Watson, Manager, Screening and Evaluation		
Tides Canada Foundation		
Catherine Emrick, Senior Associate, Aquaculture Innovation, Salmon Aquaculture Innovation Fund		
Conservation Council of New Brunswick Inc.	2011/11/29	18
Matthew Abbott, Fundy Baykeeper		
Inka Milewski, Science Advisor		
As individual	2011/12/01	19
Peter Tyedmers, Associate Professor, School for Resource and Environmental Studies, Faculty of Management, Dalhousie University		
AgriMarine Industries Inc.		
Robert Walker, President		
British Columbia Salmon Farmers Association		
Mary Ellen Walling, Executive Director		
Mainstream Canada		
Peter McKenzie, Veterinarian and Fish Health Manager		
Albion Fisheries Ltd.	2011/12/06	20
Guy Dean, Vice-President, Import and Export		

Organizations and Individuals	Date	Meeting
Overwaitea Food Group	2011/12/06	20
Betty Beukema, Director, Retail Services		
Blendle Scott, Vice-President, Innovation and Supply Chain		
SeaChoice		
Kelly Roebuck, Representative		
As individual	2011/12/08	21
Colin Brauner, Professor, Department of Zoology, University of British Columbia		
Living Oceans Society		
Catherine Stewart, Campaign Manager, Salmon Farming		
Department of Fisheries and Oceans	2012/02/06	23
Guy Beaupré, Director General, Aquaculture Management Directorate		
Jay Parsons, Director, Aquaculture Science Branch		
James Smith, Director, Certification and Sustainability Policy, Aquaculture Management Directorate		
Alistair Struthers, Team Leader, Innovation, Aquaculture Management Directorate		
Canadian Integrated Multi-Trophic Aquaculture Network	2012/02/13	24
Thierry B.R. Chopin, Scientific Director, University of New Brunswick		
Huntsman Marine Science Centre		
Bill Robertson, Executive Director		
Fraser Walsh, Chair, Board of Directors		
Open Ocean Systems Inc.		
Andrew Storey, President and Chief Executive Officer		
St. Mary's Bay Coastal Alliance	2012/02/15	25
Karen Crocker, Chair		
Brenda Patterson, Member		
Government of British Columbia	2012/02/27	26
Myron Roth, Industry Specialist, Aquaculture and Seafood, Policy and Industry Competitiveness Branch, British Columbia Ministry of Agriculture		

Organizations and Individuals	Date	Meeting
Town of Port McNeill	2012/02/29	27
Gerry Furney, Mayor		
Neil Smith, Manager, Regional Economic Development		
Royal Society of Canada	2012/03/12	28
Ian Fleming, Professor of Biology, Memorial University of Newfoundland		
Jeffrey A. Hutchings, Professor of Biology, Dalhousie University		

APPENDIX B
LIST OF WITNESSES

Third Session, 40th Parliament

Organizations and Individuals	Date	Meeting
As individual	2010/05/03	12
Brian Harvey		
University of Washington, Seattle		
Martin Krkosek, Research Associate, School of Aquatic and Fishery Sciences		
Vancouver Island University		
William Pennell, Acting Director, Institute for Coastal Research		
AgriMarine Industries Inc.	2010/05/10	14
Robert Walker, President		
Dalhousie University		
Peter Tyedmers, Associate Professor, School for Resource and Environmental Studies, Faculty of Management		
David Suzuki Foundation		
Ruby Berry, Program Coordinator, Salmon Aquaculture, Georgia Strait Alliance		
David Lane, Executive Director, T. Buck Suzuki Environmental Foundation		
Michelle Molnar, Marine Researcher and Policy Analysis		
John Werring, Aquatic Habitat Specialist, Marine and Freshwater Conservation Program		
Marine Harvest Canada		
Clare Backman, Director, Sustainability		
Vincent Erenst, Managing Director		
Simon Fraser University	2010/05/12	15
Lawrence Dill, Professor Emeritus, Department of Biological Sciences		
SOS Marine Conservation Foundation		
Catherine Emrick, Senior Associate, Aquaculture Innovation, Tides Canada		
Eric Hobson, President		
Andrew Wright, Technology Advisor		

Organizations and Individuals	Date	Meeting
Watershed Watch Salmon Society	2010/05/12	15
Craig Orr, Executive Director		
Wild Canadian Sablefish Ltd.		
Ron MacDonald, President		
Department of Fisheries and Oceans	2010/10/26	28
Trevor Swerdfager, Director General, Aquaculture Management		
As individuals	2010/10/28	29
John Allen Fraser, Chair of the former British Columbia Pacific Salmon Forum		
Jon O'Riordan, Science Research Coordinator of the former British Columbia Pacific Salmon Forum		
Aboriginal Aquaculture Association		
Richard Harry, President		
Canadian Aquaculture Industry Alliance		
Clare Backman, Sustainability Director, Marine Harvest Canada		
Ruth Salmon, Executive Director		
As individuals	2010/11/15	32
Brendan Connors, PhD Candidate, Department of Biology, Simon Fraser University		
Iñigo Novales Flamarique, Professor, Biological Sciences, Simon Fraser University		
Aboriginal Adventures Canada		
Tom Sewid, Executive Director, British Columbia Branch		
Ahousaht First Nation		
Keith Atleo, Lead Negotiator		
Sidney Sam, Elder, Fishery Committee		
BC Centre for Aquatic Health Sciences		
Sonja Saksida, Executive Director		
BC Salmon Farmers Association		
Colleen Dane, Communications Manager		
Creative Salmon Company Ltd.		
Barbara Cannon, Biology Manager		

Organizations and Individuals	Date	Meeting
Georgia Strait Alliance	2010/11/15	32
Michelle Young, Salmon Aquaculture Campaigner		
Living Oceans Society		
Catherine Stewart, Campaign Manager, Salmon Farming		
Powell River Salmon Society		
Hugh William Kingwell, President		
Squamish to Lillooet Sport Fish Advisory Committee		
Dave Brown, Vice-Chair		
Village of Tahsis		
Martin Davis, Councillor		

APPENDIX C
LIST OF BRIEFS

First Session, 41st Parliament

Organizations and Individuals
AgriMarine Industries Inc.
Atlantic Salmon Federation
Conservation Council of New Brunswick Inc.
Department of Fisheries and Oceans
Government of British Columbia
JLH Consulting Inc.
Living Oceans Society
'Namgis First Nation
Open Ocean Systems Inc.
Royal Society of Canada
SeaChoice
SOS Marine Conservation Foundation
Town of Port McNeill

APPENDIX D
LIST OF BRIEFS

Third Session, 40th Parliament

Organizations and Individuals
Aboriginal Aquaculture Association
Ahousaht First Nation
Canadian Aquaculture Industry Alliance
Kwicksutaineuk/Ah-Kwa-Mish First Nation
Marine Harvest Canada
Novales Flamarique, Iñigo
SOS Marine Conservation Foundation
University of Washington, Seattle
Village of Zeballos

REQUEST FOR GOVERNMENT RESPONSE

Pursuant to Standing Order 109, the Committee requests that the government table a comprehensive response to this Report.

A copy of the relevant Minutes of Proceedings for the Fortieth Parliament, Third Session (Meetings Nos. 12, 14, 15, 28, 29 and 32) is tabled.

A copy of the relevant Minutes of Proceedings for the Forty First Parliament, First Session (Meetings Nos. 10, 11, 12, 14 to 21, 23 to 28, 30, 48 to 51, 55 to 57, 59 to 64 and 66) is tabled.

Respectfully submitted,

Rodney Weston

Chair