SENATE SÉNAT
CANADA

VOLUME THREE – AN OCEAN OF OPPORTUNITIES: Aquaculture in Canada

Standing Senate Committee on Fisheries and Oceans

The Honourable Fabian Manning
Chair

The Honourable Elizabeth Hubley
Deputy Chair

June 2016

For more information please contact us:

by email: **pofo@sen.parl.gc.ca**
by phone: (613) 990-0088
toll-free: 1-800-267-7362
by mail: The Standing Senate Committee on
Fisheries and Oceans
Senate, Ottawa, Ontario, Canada, K1A 0A4

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MEMBERS

Senators who participated in this study:

The Honourable Fabian Manning, Chair

The Honourable Elizabeth Hubley, Deputy Chair

The Honourable Senators:

George Baker

Sandra M. Lovelace Nicholas

Thomas Johnson McInnis

Don Meredith

Jim Munson

Rose-May Poirier

Nancy Greene Raine

Carolyn Stewart Olsen

David M. Wells

The Committee would like to recognize the following Honourable Senators who are no longer serving members of the Committee whose contribution to the study was invaluable.

Lynn Beyak

Tobias C. Enverga Jr.

Ex-officio members of the Committee:

The Honourable Senators Claude Carignan, P.C., (or Yonah Martin) and James S. Cowan (or Joan Fraser).

Other Senators who have participated from time to time in this study:

The Honourable Senators: Batters, Demers, Fortin-Duplessis, Lang, McIntyre, Mercer, Plett, Tannas.

Parliamentary Information and Research Service, Library of Parliament:

Odette Madore, Analyst

Senate Committees Directorate:

Maxwell Hollins, Clerk of the Committee
Debbie Larocque, Administrative Assistant

ORDER OF REFERENCE

Extract from the *Journals of the Senate*, Monday, December 9, 2013:

The Honourable Senator Manning moved, seconded by the Honourable Senator Unger:

That the Standing Senate Committee on Fisheries and Oceans be authorized to examine and report on the regulation of aquaculture, current challenges and future prospects for the industry in Canada;

That the papers and evidence received and taken and work accomplished by the committee on this subject during the First Session of the Forty-first Parliament be referred to the committee; and

That the committee report from time to time to the Senate, but no later than June 30, 2015, and that the committee retain all powers necessary to publicize its findings for 180 days after the tabling of the final report.

The question being put on the motion, it was adopted.

Gary W. O'Brien
Clerk of the Senate

TABLE OF CONTENTS

LIST OF ACRONYMS

AAR:	Aquaculture Activities Regulations
ACOA:	Atlantic Canada Opportunities Agency
ACPRD:	Aquaculture Collaborative Research and Development Program
AIMAP:	Aquaculture Innovation and Market Access Program
AIS:	Aquatic Invasive Species
AVC:	Atlantic Veterinary College (University of Prince Edward Island)
B.C.:	British Columbia
BC CAHS:	BC Centre for Aquatic Health Sciences
BMA:	Bay Management Area
CAHS:	Centre for Aquatic Health Sciences (University of Prince Edward Island)
CAIA:	Canadian Aquaculture Industry Alliance
CCFAM:	Canadian Council of Fisheries and Aquaculture Ministers
CFIA:	Canadian Food Inspection Agency
CIMTAN:	Canadian Integrated Multi-Trophic Aquaculture Network
CITES:	Convention on International Trade and Endangered Species
COSEWIC:	Committee on the Status of Endangered Wildlife in Canada
CSSP:	Canadian Shellfish Sanitation Program
DFO:	Department of Fisheries and Oceans Canada
ELA:	Experimental Lakes Area (Ontario)
FDA:	*Food and Drugs Act*
FTE:	Full-Time Equivalent
GDP:	Gross Domestic Product
HSMI:	Heart and Skeletal Muscle Inflammation
IHN:	Infectious Hematopoietic Necrosis
ISA:	Infectious Salmon Anaemia
IMTA:	Integrated Multi-Trophic Aquaculture
IRAP:	Industrial Research Assistance Program
MOU:	Memorandum of Understanding
MUMS:	Minor use, minor species
NAAHP:	National Aquatic Animal Health Program
NAFC:	Northwest Atlantic Fisheries Centre (DFO, Newfoundland and Labrador Region)
NASAPI:	National Aquaculture Strategic Action Plan Initiative
N.B.:	New Brunswick
N.L.:	Newfoundland and Labrador
NRC:	National Research Council
N.S.:	Nova Scotia
NSERC:	Natural Sciences and Engineering Research Council
ON:	Ontario

OSC:	Ocean Sciences Centre (Memorial University of Newfoundland)
PARR:	Program for Aquaculture Regulatory Research
PCPA:	*Pest Control Products Act*
P.E.I.:	Prince Edward Island
PMRA:	Pest Management Regulatory Agency
PRV:	Piscine Reovirus
QC:	Québec
RAS:	Recirculating Aquaculture System
R-D:	Research and Development
SABS:	St. Andrews Biological Station (New Brunswick)
SMA:	Salmon Management Area
SMEs:	Small and Medium Size Enterprises
UNFAO:	United Nations' Food and Agriculture Organization

EXECUTIVE SUMMARY

The central message of this report is that there is an ocean of opportunities for aquaculture in Canada. Our country has the world's longest marine coastline, the largest number of freshwater lakes, a diversified aquaculture industry, a rigorous regulatory regime and world-class aquaculture-related research. Canada is, therefore, well positioned to help supply the growing global demand for fish and seafood and to do so sustainably – environmentally, economically and socially. The Committee supports the goal of doubling Canadian aquaculture production within the next decade. To help achieve this sustainable growth, we propose a set of recommendations articulated by five main themes: legislative and regulatory framework; healthy aquacultured fish; healthy and productive ecosystems; research and development; and, social licence and public reporting.

Legislative and Regulatory Framework

Federal Regulatory Framework

Aquaculture is a multi-faceted industry and its governance is relatively complex. This is true for Norway and Scotland, as it is in Canada. That said, national legislation governing aquaculture in Norway and Scotland ensures that companies operating in various locations in these countries are subject to a uniform and coherent set of regulations. No such legislation currently exists at the federal level in Canada. Norwegian legislation promotes aquaculture development and Scottish policy has established aquaculture production targets to reach by 2020. There are no production targets set by the federal government for aquaculture in Canada. Furthermore, Norwegian legislation limits the overall aquaculture approval process to 22 weeks and a single agency coordinates the work of all the regulatory authorities. In contrast, the lack of a streamlined application process is an issue often raised in Scotland and in Canada as the different leases, licences, permits and approvals must be obtained separately before an aquaculture facility may operate. It is estimated that the licence application process can take between 18 months and two years in Scotland, while it can last two years or more in Canada.

The involvement of different levels of governments in Canada renders the governance of aquaculture more complex than in Norway and Scotland. What further complicates the situation is that the 2009 Supreme Court of British Columbia (the *Morton* decision) created two constitutional realities with respect to aquaculture. The court ruled that aquaculture is a fishery and, therefore, under the jurisdiction of the federal government; this decision was not appealed and, as a result, Fisheries and Oceans Canada (DFO) established the *Pacific Aquaculture Regulations* which govern most aspects of aquaculture in that province. Elsewhere, there has been no litigation similar to *Morton* and the various aspects relating to aquaculture are regulated by federal and provincial governments with division of responsibilities established through bilateral Memoranda of Understanding (MOUs).

Accordingly, the extent of the federal power to regulate aquaculture will remain unsettled until the Supreme Court of Canada rules on the matter in some future case. While we understand that it is not possible to establish a clear and uniform federal regime for regulating aquaculture across the country, we nonetheless believe that a strong federal role is necessary to improve aquaculture governance across the country and stimulate investment. In our view, it is imperative that new federal aquaculture legislation be enacted. The new Act will express strong federal support for aquaculture, legitimize the industry and acknowledge its important economic contribution to rural and coastal communities. By consolidating all relevant regulations, this Act will clarify the federal role with respect to aquaculture and, in particular, it will spell out how the *Fisheries Act*

applies to aquaculture. The Committee also proposes that the new statute include a federal veto on aquaculture development in order to prevent the risk of approving an aquaculture site in a potentially unsuitable location and that it be administered by DFO. We further propose that the new Act establishes one administration within DFO charged with coordinating the activities of all federal regulatory bodies involved in aquaculture, to ensure a streamlined and effective regulatory regime. Finally, the Act will set timelines for each step of the review process leading to the various federal aquaculture authorizations and contain provisions in relation to aquaculture statistics and public reporting.

Federal-Provincial Collaboration

As noted above, the specific division of roles and responsibilities in aquaculture carried out at the federal and provincial levels varies across Canada, as a result of the *Morton* decision and the various bilateral MOUs signed in each province. The Committee often heard during fact-finding missions across the country that the level of duplication and confusion and the lack of uniformity in aquaculture governance are compounded when considered from a federal/provincial perspective. It was explained that duplication could be reduced through the sharing of information between provincial and federal departments/agencies as well as the establishment of equivalent programs whereby, for example, samples taken for monitoring and compliance purposes could be tested locally for both levels of government. The MOUs were signed in the late 1980s, when the aquaculture industry began establishing operations in Canada. In B.C., the MOU between the two levels of government was revised in 2010, following the *Morton* decision. The Committee believes that it is time for the federal government to modernize the various MOUs with each individual province. Revisions could be made in light of a new federal aquaculture Act while at the same time identifying areas for harmonization of the regulatory and policy framework to ensure that federal and provincial regulatory activities within each province are coordinated and coherent.

During the past five years, work has also been carried out under the Canadian Council of Fisheries and Aquaculture Ministers (CCFAM) as part of the National Aquaculture Strategic Action Plan Initiative (NASAPI) to address challenges associated with aquaculture governance across the country. The initiative was an ambitious plan and, although a number of tasks have been completed, much remains to be done. Five years after its launch, NASAPI has not delivered on one of the major impediments to the growth of the industry in Canada, namely the lack of uniformity in federal/provincial aquaculture governance across the country. The initiative is set to come to an end in 2015, but the Committee believes that its mandate should be extended and very focussed. It should address, as a priority, the recurring issues raised during our hearings, such as the lengthy site application and review process, the lack of uniformity from one province to another in the duration of the various licences, leases and approvals needed to run aquaculture operations, and matters that hinder operational efficiency (such as the requirement to obtain approval to change the size of net, the orientation of the cage or the placement of monitoring equipment).

Healthy Aquacultured Fish

Finfish Health

Fish health is the number one priority of all aquaculture operations. Fish are introduced into aquaculture grow-out sites disease- and parasite-free. Then, a variety of preventive measures are taken to keep aquacultured fish healthy, including: vaccination, choice of location,

maximum allowable biomass, fish health management plans, biosecurity practices, bay management areas, etc. The introduction of pathogens in grow-out sites may be attributable to an infected wild fish or contaminated equipment. For this reason, aquaculture operators require access to chemotherapeutants to minimize the impact of these pathogens.

The Committee learned that Canadian aquaculture operators do not have access to the same range of pest control products and veterinary drugs as producers in other countries, including Norway and Scotland, and are therefore at a disadvantage on global markets. It was explained that the market for these products in Canada is too small to enable drug manufacturers to recoup the fixed costs associated with drug development, approval and marketing. We were told that classifying aquatic animal products under a "minor use minor species" (MUMS) template would reduce the cost associated with their registration/approval and would allow for the fast-tracking of products, while still ensuring their safety. Fish health is the foundation of the aquaculture industry and, for this reason, we believe that the Canadian aquaculture industry must be given improved and timely access to a range of drugs and pest control products through a MUMS Program for Aquaculture.

The Committee also learned that sea lice infestations are an ongoing concern worldwide in salmon aquaculture. The parasite latches onto the fish and inflicts damage both directly by feeding on the host's body and indirectly by making the host more vulnerable to secondary infections. The potential for reduced effectiveness in drug treatment and the desire to limit reliance on chemotherapeutants has led to the development of several non-chemical technologies to manage sea lice, including: cleaner-fish, snorkel cage, IMTA, mechanical removal, etc. In our view, research into sea lice epidemiology and the effectiveness of non-chemical methods need to continue. More importantly, the use of proven effective non-chemical methods must be encouraged and the use of drugs and pest control products reserved for occasional use.

Fish Feed

Finfish held in aquaculture operations are fed with special pellets designed to meet their nutritional requirements and allow for optimal health and growth. Schedule 5 of the regulations developed pursuant to the federal *Feeds Act*, which is administered by the CFIA, lists the additives or ingredients that can be used in fish feed formulations. The Committee was told that a number of feed additives which are not approved for use in the formulation of fish feed in Canada are permitted in other countries, including Norway and Scotland. Fish that have been fed using these ingredients can be imported into the country, which, in the view of several witnesses, makes little sense. In addition, some of these feed additives stimulate the immune system and increase the resistance of salmon to sea lice infestations. The Committee concurs with witnesses that there is some incoherence in federal aquaculture governance. In our view, the current regulations governing fish feed additives stifle innovation for development of improved diets and impede the industry's global competitiveness; they must be revised.

Shellfish Health

The Committee learned that several shellfish aquaculture operations on the East and West Coasts are afflicted by aquatic invasive species (AIS), such as the green crab, clubbed tunicate and vase tunicate. Some of these AIS prey directly on the cultured shellfish, while others out-compete them for habitat and resources. AIS affect growth and meat yield and cause increased maintenance and labour costs for growers and processors. The

Committee was told that, once an invasive species has become established in an area, it is essential to develop innovative technologies and practices to effectively manage it. We support this suggestion. In our view, it is especially important to initiate a rapid response in the early stages of invasion.

Healthy and Productive Ecosystems

Environmental Impact of Marine Finfish Aquaculture

It was explained to the Committee that, during the functioning of marine finfish aquaculture operations, organic material is released into the surrounding waters. Some of this material settles on the seabed at or near the cage sites where it can accumulate, while some is dispersed into the water column, spreading the wasted organic matter beyond the perimeter of the aquaculture site. Accordingly, aquaculture operations generate both near-field (localized) and far-field (distant) effects. Research conducted in Canada and Norway suggests that aquaculture has a low impact on the benthic environment, particularly in the near-field. The far-field effects, however, take longer to develop, are more difficult to detect and thus less understood. The Committee believes that these effects, which may include changes in planktonic communities around finfish operations and eutrophication, require further study.

We also heard particular concerns about the potential impact of sea lice treatments on non-target organisms, more particularly on lobster. To date, research has shown that the dilution, dispersal and toxicity levels of different sea lice control products vary with the pesticide used, the treatment method and water flow regimes. While we recommend access to a wider range of products provided by a MUMS Program for Aquaculture, we nonetheless recommend further study on the effects of these products on non-target organisms.

Impact on Wild Salmon Stocks

The escape of aquacultured fish and its impact on wild fish stocks were discussed at length during the Committee's study. On the West Coast, we learned that the risk to wild Pacific salmon stocks from escaped aquacultured Atlantic salmon is low; there is minimal interaction between the aquacultured Atlantic salmon and the wild Pacific salmon, either through competition for habitat and food or as predators. In addition, escaped aquacultured Atlantic salmon has not been shown to successfully mate with wild Pacific salmon.

On the East Coast, however, research has shown that Atlantic salmon escapes can successfully mate with wild fish of their own breed and that such interbreeding reduces the new generation's ability to survive in the wild. Larger (and therefore healthier) wild populations appear to be more resilient and therefore less affected by the escapes of aquacultured salmon. Conversely, weaker wild populations (such as those endangered or threatened) appear to be more affected by the escaped salmon and show more signs of genetic change due to interbreeding. Although the Committee is encouraging the sustainable growth of the aquaculture industry in Canada, we believe that such growth should not be supported to the detriment of wild salmon stocks. Accordingly, restrictions should be considered to ensure that aquaculture operations growing Atlantic salmon on the East Coast are located far from wild salmon populations that are deemed to be at risk.
We were pleased to learn that DFO struck the Ministerial Advisory Committee on Atlantic Salmon in an effort to better understand the health of wild salmon populations on the East Coast. This information could help DFO and the aquaculture industry to re-evaluate, if necessary, the location and functioning of aquaculture operations growing Atlantic salmon, as well as help determine the risk associated with any new proposed aquaculture sites.

On the West Coast, witnesses also spoke about the potential for transfer of disease and parasites between aquacultured and wild fish. The effect of sea lice infestations on wild salmon populations was debated. Some witnesses expressed concerns about wild juvenile salmon swimming near aquaculture grow-out sites during their outmigration. They explained that, at that stage, the fish are very small and they do not have a scale load: when one or two sea lice attach to them, they either die or become crippled and subject to predation or other pathogens. In contrast, some research presented to the Committee showed that sea lice in aquaculture grow-out sites did not play a significant role in the decrease of wild Pacific salmon productivity. Other experts explained that the risk of disease being transferred from aquacultured fish to wild fish is low: diseases from aquaculture sources kill less than 1% of wild salmon per year; this rate, it was stressed, is much lower than the estimated natural mortality of juvenile wild salmon of 3% per day. Overall, the Committee recognizes that there is a lack of knowledge about the health of wild Pacific salmon stocks. We were pleased to learn about the Strategic Salmon Health Initiative, a collaborative study by DFO, the Pacific Salmon Foundation and Genome BC. The study intends to assess the presence and/or absence of 45 pathogens in samples collected in wild, hatchery and aquacultured salmonids in B.C. between 2012 and 2018. It is the view of the Committee that this research will inform improved risk assessment related to pathogen transfer from aquacultured to wild salmon.

Environmental Impact of Shellfish Aquaculture

The Committee heard less testimony on the potential environmental impacts of shellfish aquaculture, in comparison with marine finfish aquaculture. However, witnesses who spoke about specific environmental concerns regarding this sector raised important issues. In B.C., certain shellfish aquaculture operations have been known to generate large amounts of debris, such as plastic and Styrofoam®, which are left in waters and on shores. In addition, when production comes to a close at certain locations, gear and other apparatus are abandoned in the water instead of being removed. Although these operations only represent a limited number of shellfish growers across Canada, they hinder the reputation and social licence of other shellfish growers that are vigilant in their use of the environment and considerate of other users. The Committee cannot in good conscience condone operations working in this manner.

DFO is responsible for licensing shellfish aquaculture in B.C. and, accordingly we recommend that the Department strictly enforce compliance with the licence conditions and the provisions under the *Pacific Aquaculture Regulations*. In our view, site debris should be managed appropriately in all aquaculture sectors – shellfish and finfish – and in all regions – both the West and East Coasts.

Research and Development

Collaborative Research

There is a strong foundation of aquaculture research and development (R-D) in Canada. At the federal level, a number of departments and agencies fund, carry out and/or collaborate on aquaculture-related research. During site visits throughout Canada, the Committee visited several research facilities that have been performing world-class R-D on a wide range of topics related to aquaculture for decades. This research has helped improve the industry's environmental performance and led to stricter government regulations. During our fact-finding missions to Norway and Scotland, we were told that Canada is internationally recognized for the high calibre of its aquaculture R-D and that the effectiveness of its research could be further improved through stronger collaboration.

Witnesses told the Committee that the federal government had reduced its investment in aquaculture R-D programs in recent years. Given limited resources, we believe that it is imperative to prioritize research that improves the environmental management and performance in aquaculture. Furthermore, priority funding should be given to collaborative work. To achieve this, we recommend that a formal mechanism fostering R-D collaboration between all stakeholders be developed. This mechanism will facilitate the sustainable growth of the industry.

Synthesizing Research and Communicating its Findings

During Committee hearings, witnesses often pointed to the need to synthesize the results of current research. They explained that, while a considerable amount of R-D has been conducted on the effects of aquaculture on the environment in Canada and abroad, this body of research has never been compiled, synthesized, and interpreted. We share their views. This exercise, albeit a large undertaking, will identify gaps in R-D that require further study. Moreover, the Committee was told that the results of this exercise should be communicated to the general public in a way they can easily assimilate. In our view, this information will contribute to more informed discussions and debates on aquaculture and help everyone understand how the industry can continue to operate and grow sustainably into the future.

Social Licence and Public Reporting

Reporting to the Public

Public concern about the potential environmental effects of aquaculture is high in some parts of the country. Some of these concerns are genuine and stem from irresponsible practices and/or inadequate management. Correcting these situations will certainly improve the aquaculture industry's social licence. For industry, this means being responsible and capable of demonstrating its sustainability. For government, this means adopting and enforcing a rigorous and science-based governance framework that protects precious resources – our wild salmon stocks, other wild fish populations, and sensitive habitats – and preserves them for years to come.

Public trust can also be improved by government openly providing information about the aquaculture industry and disclosing the industry's environmental performance data. Norway and Scotland release information to the public on a wide range of topics related to aquaculture and such information is shown to enhance the industry's social licence. In Scotland, the main departments and agencies regulating the industry have joined to establish a website that serves as a single point of access to a database on aquaculture. There is no single agency reporting information about the industry to the public in Canada. The information that is currently available is found in separate locations; it is not released in a timely fashion and is very limited compared to what is publicly accessible in Norway and Scotland. Under the proposed *Aquaculture Activities Regulations*, DFO will collect and release annually data on benthic monitoring as well as on the use of veterinary drugs and pest control products in aquaculture operations. These data, however, will be aggregated, not presented for each operator. Other information about aquaculture operations will also be available from provincial regulatory departments and agencies. The Committee makes a recommendation to ensure that Canadians seeking information on aquaculture operations can find it in a single convenient place.

LIST OF RECOMMENDATIONS

LEGISLATIVE AND REGULATORY FRAMEWORK

1. **That Fisheries and Oceans Canada introduce a federal aquaculture Act that responds to the concerns voiced during the Committee study and that asserts the full extent of federal jurisdiction. The Committee further recommends that the Act include the following:**

- **a strong preamble that expresses federal support for the orderly expansion of an environmentally, economically, and socially sustainable aquaculture industry and that recognizes the important economic contribution of the industry in remote, rural, and coastal communities across the country, including First Nations;**

- **a consolidation of existing and proposed federal regulations governing aquaculture currently under the *Fisheries Act*;**

- **an explicit power for the Minister of Fisheries and Oceans to veto any proposed aquaculture site that, in the Minister's opinion, poses an unacceptable risk of harm to wild fish or fish habitat, or other environmental risks;**

- **a new administration housed within Fisheries and Oceans Canada charged with the coordination of the federal regulatory role in aquaculture. The new administration should be a one-stop shop responsible for all federal functions in aquaculture – including those of the Canadian Food Inspection Agency, Environment Canada, Transport Canada, Fisheries and Oceans Canada and others – to ensure a streamlined and efficient regulatory regime for aquaculture;**

- **timelines for the diverse federal decisions on aquaculture authorizations; and**

- **non-regulatory provisions in relation to aquaculture statistics and public reporting on the operation of the industry.**

2. **That Fisheries and Oceans Canada renegotiate existing bilateral Memoranda of Understanding on Aquaculture Management within 18 months of the coming into force of the new federal aquaculture Act to accelerate harmonization and reduce duplication; and**

- **That the National Aquaculture Strategic Action Plan Initiative be extended for another two-year term and be mandated to complete work on national consistency and simplicity in aquaculture regulation.**

HEALTHY AQUACULTURED FISH

3. **That Fisheries and Oceans Canada develop and establish with Health Canada and the Pest Management Regulatory Agency a Minor Use, Minor Species Program for Aquaculture.**

4. **That the Canadian Food Inspection Agency revise Schedule 5 of the regulations under the *Feeds Act* to include a wider range of additives or ingredients for use in the formulation of fish feed.**

5. **That Fisheries and Oceans Canada work with the provinces and the aquaculture industry to evaluate, within the next two years, new technologies and methods for the effective management of aquatic invasive species in the shellfish aquaculture sector.**

HEALTHY AND PRODUCTIVE ECOSYSTEMS

6. **That Fisheries and Oceans Canada undertake collaborative research on the far-field effects of marine finfish aquaculture and on the potential impacts of pest control products used for sea lice management on non-target organisms; these fields of research should be given priority.**

7. **That Fisheries and Oceans Canada regularly undertake inspections and consistently enforce compliance in relation to shellfish aquaculture in British Columbia and, in particular, in situations where any floating material or other debris (such as shells, ropes, and buoys) is not disposed of as prescribed and/or remains in the marine environment; the Department should equally act in situations where aquaculture operators in other provinces leave debris in the marine environment.**

RESEARCH AND DEVELOPMENT

8. **That Fisheries and Oceans Canada develop without delay a formal mechanism with the provinces, the research community and the industry to foster collaborative research and development in the field of aquaculture.**

9. **That Fisheries and Oceans Canada complete within the next two years a thorough assessment of aquaculture research to inform the public on the main findings and identify gaps in research and development that would become the focus of future research.**

SOCIAL LICENCE AND PUBLIC REPORTING

10. **That Fisheries and Oceans Canada, with input from the provinces via the Canadian Council of Fisheries and Aquaculture Ministers, establish within the next two years a central database accessible to the public that contains all currently available information pertaining to the licence and compliance of each aquaculture operator.**

INTRODUCTION

With the tabling of Volume Three, the Standing Senate Committee on Fisheries and Oceans (the Committee) has come to the end of a long journey that began in December 2013, during the 2nd session of the 41st Parliament, when the Committee received a mandate from the Senate "to examine and report on the regulation of aquaculture, current challenges and future prospects for the industry in Canada."[1]

Volume Three is therefore the culmination of an 18-month-long study on aquaculture. During this period, the Committee sat for 66 hours, held 34 public hearings, heard the views of 138 witnesses, and received hundreds of written submissions and other documentation. Senators also visited 23 Canadian regions in six provinces – British Columbia (B.C.), New Brunswick (N.B.), Newfoundland and Labrador (N.L.), Nova Scotia (N.S.), Prince Edward Island (P.E.I.), and Québec (QC) – and completed fact-finding missions in Norway and Scotland. Overall, the Committee met with a wide range of groups and individuals who shared their views about aquaculture, including: officials from regulatory bodies, industry representatives, workers employed in various segments of the industry, academics, researchers in not-for-profit organizations and government establishments, First Nations Chiefs and other Aboriginal individuals or groups, salmon conservation organizations, representatives from the commercial capture fisheries and recreational fishing sectors, mayors, community groups, and individual citizens.
We wish to express our sincerest thanks to all those who took the time to appear as witnesses before the Committee as well as all those who welcomed us warmly during our site visits. We gave serious consideration to their comments and suggestions as we developed our own observations and conclusions about aquaculture and the challenges and prospects for this industry in Canada.

Overall, our main message is that there is an ocean of opportunities for aquaculture in Canada. We are confident that the Canadian aquaculture industry can grow steadily within the next 10 years and do so sustainably – environmentally, economically and socially. To help achieve this sustainable growth, we propose a set of recommendations articulated by five main themes: Legislative and Regulatory Framework; Healthy Aquacultured Fish; Healthy and Productive Ecosystems; Research and Development; and Social Licence and Public Reporting. Deadlines are associated with most of our recommendations and are set to start with the tabling of this report.

This volume outlines the Committee's rationale for support of a growing sustainable aquaculture industry in Canada. It also addresses environmental considerations and proposes recommendations on what can be done to overcome constraints and impediments that keep Canada from achieving its full aquaculture potential. In our view, the set of recommendations that we propose will ensure that a robust legislative and regulatory framework exists for aquaculture – one that enables the growth of the industry, protects the broader aquatic environment, ensures its sustainability, and generates much needed tangible and long term economic benefits in many regions of the country and to Canada as a whole.

We encourage readers to consult Volume One and Volume Two to learn more about the aquaculture industry and its governance in Canada, Norway and Scotland.[2]

1 Senate of Canada, ***Journals of the Senate***, 2nd Session, 41st Parliament, 9 December 2013, p. 274.
2 Please note that, in this document, the testimony received from witnesses and printed in the ***Minutes of Proceedings and Evidence of the Standing Committee on Fisheries and Oceans*** will be hereinafter referred to only by issue number and page number in brackets within the text.

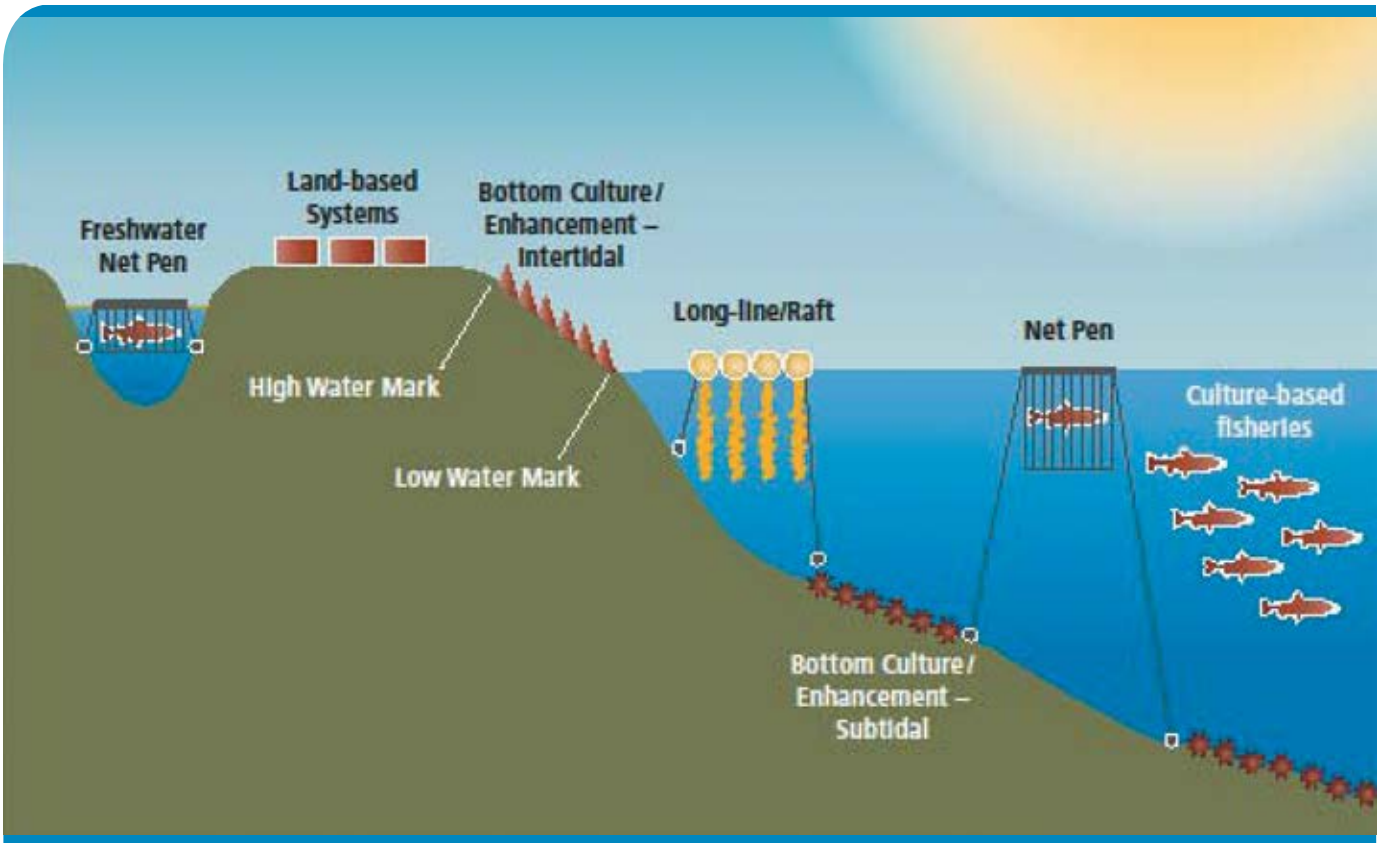
CHAPTER 1: Aquaculture: a Growing Industry

1.1 What is Aquaculture?

Aquaculture is the cultivation and harvesting of aquatic organisms – finfish, shellfish, molluscs and aquatic plants. Aquaculture can take place in a variety of environments – in the ocean (in coastal areas and offshore), in freshwater (in lakes and ponds) and on land (in tanks). The cultivation of a single species is usually referred to as a monoculture, while the cultivation of two or more complementary species in a same location is referred to as a polyculture or integrated multi-trophic aquaculture (IMTA). The techniques and technologies used in aquaculture vary depending upon the environment chosen and the species being cultivated. The principal categories of aquaculture operations are represented in Figure 1.

Cage aquaculture or "net pen" operations are used to grow finfish in freshwater and in marine environments. They have infrastructure both below and above water, which consists of floating

Figure 1 – Types of Aquaculture Operations



Source: Fisheries and Oceans Canada, ***Aquaculture in Canada in 2012: A Report on Aquaculture Sustainability***, 2012, p. 7 [REPRODUCED WITH PERMISSION].

containment structures anchored to the bottom to keep them in place, and the cages are usually surrounded by metal walkways. The net mesh sizes vary depending on the size of the fish being reared. Additional netting is often attached around the containment structures to discourage predators and a top cover also protects fish against birds. Fish raised in marine cage aquaculture are usually fed by automatic feeders that rely on underwater cameras to monitor feeding behaviour and control feed delivery; such monitoring helps ensure that fish have enough to eat while minimizing waste and reducing the impact of uneaten feed on water quality. Trout is often cultivated in freshwater, while a variety of finfish species (such as salmon, sablefish, and steelhead) are grown in the ocean. Marine cage aquaculture operations often have additional floating infrastructure including an office, fish health lab, feed storage area, and accommodation for staff. Most aquaculture in freshwater and marine environments operates in public waters. While cage aquaculture is the method used in the cultivation of finfish in Canada, closed and semi-closed floating containment technologies have been tested in freshwater and marine environments. These technologies seek to isolate the rearing environment from the natural environment in order to reduce or eliminate the interactions between the two.

Other marine aquaculture methods are used to grow a variety of shellfish species. Bottom culture in the intertidal zone consists of planting shellfish directly in the substrate of the beach. This method is used to grow clams and is also used for oysters during their nursery rearing (before being placed in grow-out sites in deeper water). Bottom culture within the sub-tidal zone is virtually identical to bottom culture in the intertidal zone, the principal difference being the location of the activities. Species such as scallops and geoducks (a large species of clam) are usually raised in a hatchery or rearing environment and then transferred onto the seabed using an underwater mechanical seeder. Long-line and raft culture operations in sub-tidal waters consist of ropes, trays, and rafts that are anchored to the seabed. This method – which is termed either as "water column culture", "off-bottom culture" or "suspended culture" – is used to grow a variety of species, including mussels, oysters and scallops (as well as aquatic plants). In contrast to finfish, shellfish only feed on naturally-occurring organisms found in the water. Furthermore, the shellfish aquaculture sector relies (to a great extent) on wild seed collection, in contrast to the finfish sector which obtains smolt from hatcheries.

Culture-based fisheries or "sea ranching" is a specific form of aquaculture that is used to supplement wild stocks with hatchery-produced fish. Examples include the Salmonid Enhancement Program in B.C. and the Alaskan culture-based salmon fishery. Culture-based fisheries are not discussed in this report.

Land-based, closed-containment facilities operate on private property and use recirculating aquaculture systems (RAS) to grow a variety of species, such as trout, char, sturgeon, and halibut. Most often, however, land-based RAS are used by the salmon aquaculture sector; these are hatcheries that grow smolt, accounting for about one third of the fish's lifecycle.[3]

During fact-finding missions in Canada and abroad, the Committee had the opportunity to visit different types of marine aquaculture operations – seven finfish and two shellfish grow-out sites,

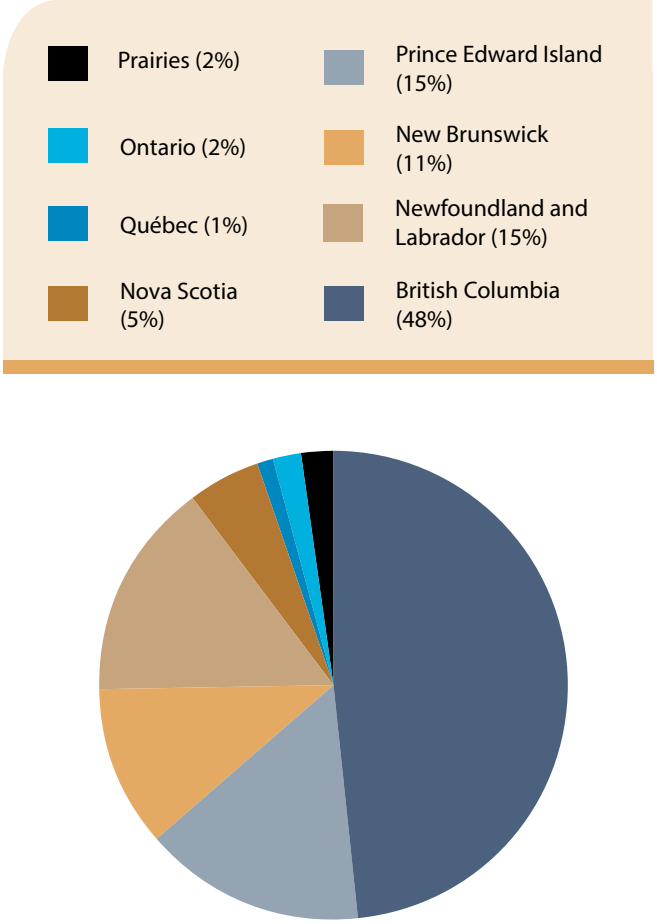
3 RAS utilizes intensive filtration processes to enable more than 90% of total process water to be continually reused within the system.

as well as two IMTA operations – and a variety of land-based RAS establishments, including three salmon smolt hatcheries, one sea scallop hatchery/nursery and three closed-containment facilities supplying niche markets. Overall, we learned a lot about the growing techniques and technologies used in aquaculture and we were impressed by the level of scientific knowledge developed by and for the industry and the robust biosecurity measures required to operate effectively and safely.

Furthermore, these site visits allowed the Committee to acknowledge the diversity of the industry, particularly across the country, and to better understand the aquaculture value-chain, which goes beyond hatchery and grow-out operations and encompasses a wide range of activities, such as net cleaning, diving services, equipment maintenance and repair, boat transportation, fish feed production, veterinary services, equipment manufacturing, fish processing, packaging supplies, and marketing. All these activities generate added value in both the upstream and downstream sectors.

We saw first-hand the important contribution the aquaculture industry makes to Canada's economy. Currently, aquaculture represents about a third of Canada's total fish and seafood production by value and 20% by volume. National aquaculture production, including both the marine and freshwater sectors, is divided about equally between the West and East coasts. As shown in Figure 2, B.C. accounted for about 48% of the total production volume in 2013, followed by P.E.I. and N.L. at 15%, N.B. at 11%, N.S. at 5%, Ontario (ON) and the Prairies at 2%, and QC at 1%. In addition, there is some aquaculture production in the Yukon Territory (however, the volume produced is too small to appear in Figure 2). In the Committee's opinion, regions across the country can all benefit from a growing and sustainable aquaculture industry.

Figure 2: Aquaculture Production in Canada by Province (Percentage of Volume), 2013



Source: Fisheries and Oceans Canada, ***Aquaculture – Production Quantities and Values*** [accessed 21 April 2015].

1.2 Canadian Aquaculture in the Global Economy

Fish and seafood are healthy and nutritious food choices and the global demand for these products is steadily increasing. Currently, nearly 50% of the fish and seafood consumed worldwide – 66 million tonnes – is produced from aquaculture. Given the stability in global capture fisheries production, the United Nations' Food and Agriculture Organization (UNFAO) forecasts that aquaculture will need to supply an additional 40 million tonnes to feed the rising world population by 2030.[4] Clearly, aquaculture is here to stay.

Canada has the world's longest marine coast line and the largest number of freshwater lakes. In addition to its abundance of "pristine" water, this country has a diversified (albeit modest) aquaculture industry, a rigorous regulatory regime and world-class aquaculture-related research. Canada is therefore well positioned to help supply the growing global demand for fish and seafood and to do so in a sustainable manner. Although Canada is the 4th largest salmon producer worldwide, behind Norway, Chile and Scotland, it remains a relatively small global aquaculture producer, ranking 21st (finfish and shellfish combined).

Between 2003 and 2013, total aquaculture production in Canada grew by 0.4% on average annually, while average annual growth reached almost 20% between 1986 and 2002 (see Figure 3). In comparison, aquaculture production grew by 8.0% on average annually in Norway and by 1.5% in Scotland between 2003 and 2013. The Scottish Government aims to produce 226,000 tonnes of aquacultured products by 2020, or an average growth of 5% per year. The Norwegian Government has not set specific aquaculture production targets but is committed to sustainable industry growth. There are no production targets set by the federal government for aquaculture in Canada at this time.

The Canadian Aquaculture Industry Alliance (CAIA) estimates that Canada could more than double its aquaculture production within 10 years (2014-2024), from about 173,000 to over 378,000 tonnes of finfish and shellfish.[5] This potential growth of 205,000 tonnes in Canadian aquaculture production over the next 10 years is less than Norway's aquaculture production increase of 301,000 tonnes between 2010 and 2012. CAIA's estimate is based on the following assumptions: an average annual production growth of 5% achieved through productivity improvements at existing aquaculture sites during the first five years; and, an average annual production growth of 10% during the following five years, achieved through a 38% increase in new sites.

The Committee wishes to note that the 5% average annual production growth between 2014 and 2019 is similar to the target established in Scotland. The 10% average growth in production between 2019 and 2024 remains much below the growth rate experienced between 1986 and 2002, when the industry established itself in Canada. Achieving these growth rates sustainably would allow Canada to become more competitive on global markets and to better position itself as a world leader in sustainable aquaculture production.

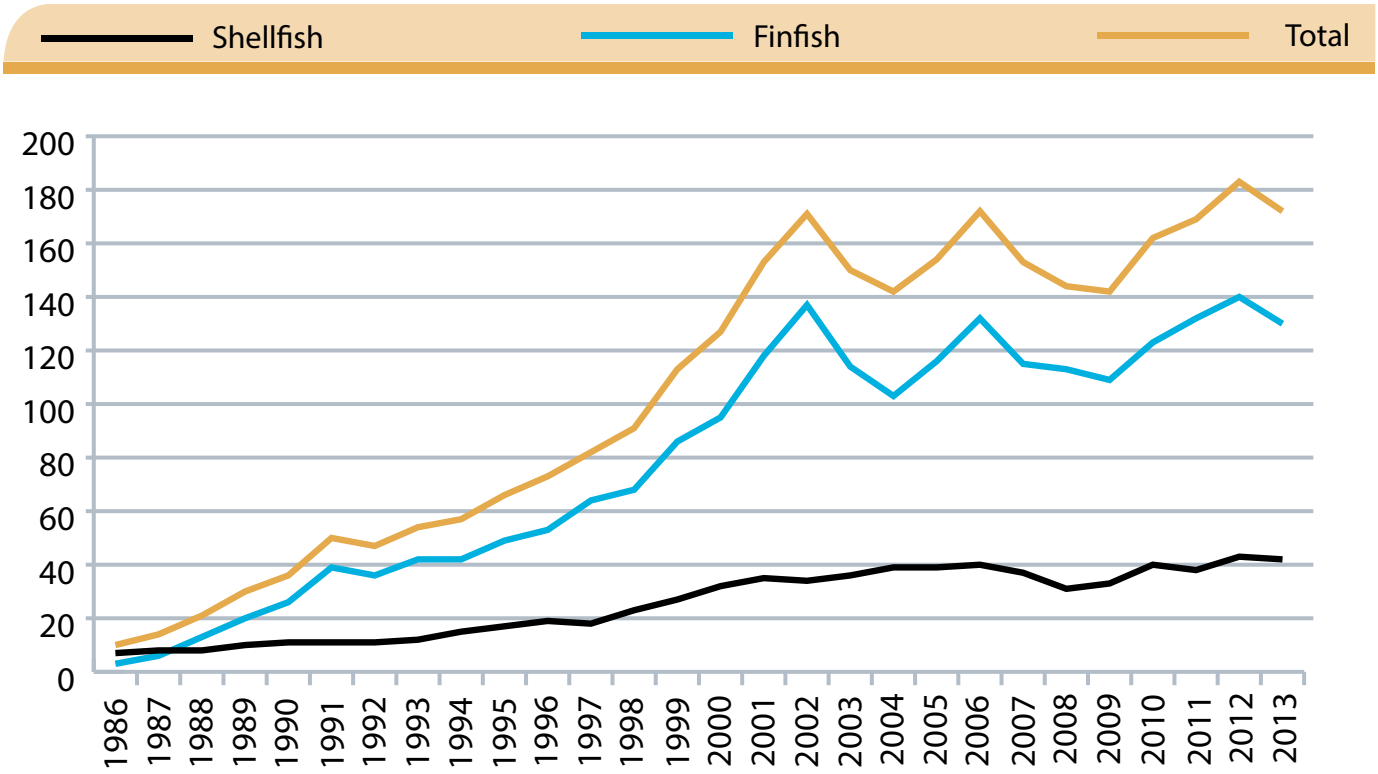
The Committee is willing to support the goal of doubling aquaculture production within the next decade, provided the following occurs: the adoption of legislative and regulatory reforms that

4 UNFAO, ***The State of World Fisheries and Aquaculture***, 2014.
5 Canadian Aquaculture Industry Alliance, *Canada's Aquaculture Industry: Potential Production Growth and Footprint*, 17 November 2014.

contribute to a rigorous governance regime and sound aquaculture management practices that minimize impacts on the environment – all informed by world-class research and development. Altogether, these conditions should help gain and maintain strong public support for Canadian aquaculture, while creating a business climate favorable to the industry's sustainable development.

Parallel to this development in the marine and freshwater aquaculture sectors, the Committee further believes that new opportunities for growth should be encouraged in the areas of land-based, closed-containment aquaculture, the monoculture of aquatic plants, and IMTA, given Canada's comparative advantage in these sectors.

Figure 3: Aquaculture Production in Canada (in Thousands of Metric Tonnes), 1986 to 2013



Source: Fisheries and Oceans Canada, ***Aquaculture – Production Quantities and Values*** [accessed 21 April 2015].

1.3 Contribution of Aquaculture to the Canadian Economy

> *For many years, (...) economic development was at a virtual standstill in Charlotte County until aquaculture came to our shores in about the late 1980s. Now, one out of four jobs in Charlotte County are directly or indirectly related to the aquaculture industry, driving millions of dollars into our local economies, and as a result of this certainty of consistent, year-round employment that the aquaculture industry offers, young families are purchasing homes and buying cars and generally pumping their disposable income into our local economies. Further, I am certain many of those dollars find their way to the economies of Saint John, Moncton and Fredericton. (...)Industry representatives can be found coaching teams, local teams, they are volunteer firefighters, school mentors, and they contribute financially to our recreational and cultural facilities. In my view, the aquaculture industry promotes healthy, sustainable communities in their entireties, and it is my hope that all levels of government assist this industry in their regulatory processes so that communities such as ours can continue to experience both social and economic growth and development. Teresa James, Mayor, Village of Black's Harbour (14:92-93)*

In Volume One and Volume Two, the Committee discussed the results of studies that estimated the economic repercussions of the aquaculture industry in Canada, Norway, and Scotland. These studies explained that, in addition to producing its own output, the aquaculture industry triggers activity elsewhere in the economy through direct, indirect and induced impacts. The direct impacts are those associated with hatchery and grow-out activities. Indirect impacts estimate the activities generated by other industries that provide goods and services to the aquaculture industry. Induced impacts account for all spending that occurs in the economy generated from individuals employed in direct aquaculture operations and in indirect industries; these individuals spend their income in other areas of the economy on items such as cars, housing, and other retail goods.

The Canadian study showed that the aquaculture industry generated over $1 billion in Gross Domestic Product (GDP) in 2010, with $354 million in direct GDP and $710 million in indirect and induced impacts. The industry created 5,828 direct full-time-equivalent jobs (FTEs), with an overall employment impact of over 14,000 FTEs. It generated direct labour income of $193 million, with an overall income impact of $618 million. According to the study, the aquaculture industry has helped revitalize remote, rural and coastal communities, including First Nations and other Aboriginal communities, and is, overall, an important sector of economic activity for Canada. The Committee wishes to stress that the indirect and induced impacts generated by the aquaculture industry and its contribution to other regions, through processing and other support activities, often remain unrecognized but are nonetheless substantial.

That said, this industry has great potential. According to the CAIA, if the goal of doubling aquaculture production by 2024 were met, this could mean a total economic impact of $2.5 billion in GDP every year and the ongoing overall employment of 32,500 FTEs.[6] The Committee believes that, for this to be fully realized, the industry must continue to demonstrate its commitment to improved environmental performance and sustainable growth,

6 Ibid.

along with a research and academic community that is well positioned to underpin that development. We want to see the aquaculture industry continue to thrive, using world-leading science and research to guide its sustainable growth.

1.4 Areas Suitable for a Growing Industry

According to the CAIA, the Canadian aquaculture industry currently produces 45 different species of finfish and shellfish, as well as a few species of aquatic plants, using approximately 37,000 leased hectares of coastal areas and lakes or about 1% of the potential areas biophysically suitable for aquaculture.[7] Achieving the goal of doubling aquaculture production within the next 10 years would require a total of 51,400 leased hectares, or 1.35% of the total biophysically suitable area, leaving "(...) untouched much of the water area biophysically suitable for aquaculture in Canada".[8]

Currently, however, it is unclear where the areas of greatest expansion potential are located in Canada. In this respect, Scotland is more advanced: coastal areas suitable, potentially suitable or unsuitable for marine finfish aquaculture development have been identified[9] and further guidance on the most appropriate location is provided in relation to visual and landscape considerations.[10] Only P.E.I. has a similar system which designates zones – as acceptable, conditional or not acceptable – where shellfish aquaculture operations can or cannot be located. A system of classification for marine finfish aquaculture based on the Scottish model has been proposed in N.S. by an independent review panel, but the provincial government has not yet responded to this recommendation. Research is underway in N.L. to investigate the oceanographic conditions in some regions of the province in order to identify areas offering further aquaculture development potential. Similarly, work is ongoing in QC to establish zones where shellfish aquaculture could be established. In N.B., the development of additional marine finfish aquaculture sites in coastal areas is very limited, although there are possibilities for establishing aquaculture operations offshore. This being said, there is potential for further development of the shellfish sector in the province; it is however unclear whether research has been undertaken to identify zones suitable or unsuitable for this purpose. In B.C., the long Pacific Coast, with its relatively temperate waters, is ideally suited for aquaculture, but again, it is unclear whether there is active investigation to identify sites suitable for aquaculture. Furthermore, there is interest in developing seaweed aquaculture and IMTA in several provinces (B.C., N.B., N.S., and QC) and suitable locations should also be identified to accommodate these sectors.

The Committee believes that work must continue to determine the areas that are most suitable for aquaculture growth in the marine and freshwater environments (for finfish, shellfish, and aquatic plants, as well as for IMTA). This work must take into account the potential environmental impacts, competing claims from other users, the landscape and visual aspects of aquaculture infrastructure, and the local community's acceptance of such

7 Ibid.
8 Ibid.
9 Marine Scotland Science, ***Locational Guidelines for the Authorisation of Marine Fish Farms in Scottish Waters***, March 2015.
10 Scottish Natural Heritage, ***The Siting and Design of Aquaculture in the Landscape: Visual and Landscape Considerations***, November 2011.

aquaculture development. We were told that First Nations know a great deal about the areas where they live, the surrounding waters and the aquatic ecosystems they depend on for their sustenance. This knowledge has been accumulated through generations of living in close contact with nature. The search for suitable aquaculture sites will greatly benefit from Aboriginal traditional knowledge early on in the process, along with more conventional scientific knowledge.

1.5 Emerging Technologies

1.5.1 Land-Based, Closed-Containment Technologies

For a variety of reasons, the use of RAS facilities is likely to increase. This is particularly true of freshwater RAS salmon hatcheries and smolt production units that would be needed to achieve the potential expansion of finfish aquaculture in Canada. There is also recent interest in both Norway and Scotland in rearing Atlantic salmon to an interim weight of 1 kg before transfer into marine net cages, in order to reduce interactions with wild fish populations. Such an approach may also be explored in Canada, further increasing the use of RAS technology.

Similarly, land-based RAS supplying niche markets can be expected to face an increasing demand for their seafood products. Throughout its fact-finding missions, the Committee had an opportunity to meet with innovative entrepreneurs, tour their RAS facilities and discuss future opportunities and challenges with them. A few examples include:

- In B.C., the Committee had the opportunity to visit Taste of B.C. Aquafarms Inc., a small RAS facility located in Nanaimo that raises Steelhead trout. During the tour, we were told that there is great potential for smaller "family farm scale" land-based, closed-containment facilities in developing niche markets for their products.
- In N.B., the Committee visited Breviro Caviar, a company that grows shortnose sturgeon for both meat and caviar. The company operates three land-based, closed-containment facilities in the province, located in St. Andrews, Pennfield and Charlo. Breviro is the only company in the world to hold the licence under the Convention on International Trade and Endangered Species (CITES) to grow and sell caviar from the shortnose sturgeon.
- In P.E.I., the Committee toured Halibut P.E.I., a land-based facility growing Atlantic halibut. The company purchases juveniles from Scotian Halibut Limited (N.S.) and grows them in tanks using salt water sourced from underneath the Island through wells.
- In QC, the Committee visited Fermes marines du Québec Inc., which is involved in the production of scallops and operates a hatchery and several grow-out sites. More particularly, we toured the hatchery located in Newport in the Gaspé region, a state-of-the-art building which uses saltwater and is entirely automated with touchscreen panels.

During the hearings, the Committee also heard more about land-based, closed-containment technologies:

- The 'Namgis Salmon Farm, also called the Kuterra Project, located near Port McNeill, B.C., is the first land-based, closed-containment facility in Canada that succeeded in producing Atlantic salmon at a commercial scale. The project benefited from several public and private organizations that financed its initial capital costs of about $9.5 million. The construction began in December 2011, the

first smolt entered the facility in March 2013 and the first harvest of Atlantic salmon occurred in April 2014. The Kuterra Project currently sustains five FTEs in this First Nations community.

- Scotian Halibut Limited is a N.S. company operating a hatchery and broodstock facility in Clark's Harbour, and a land-based RAS facility in Lower Woods Harbour. The company is the largest marine hatchery in Canada, the second largest producer of halibut juveniles in the world and the largest producer of market halibut in Canada.

- Sustainable Blue, a land-based RAS facility growing Arctic char, European sea bass and rainbow trout in Centre Burlington, N.S., also began growing Atlantic salmon as a demonstration project in June 2013. The trial produced encouraging results prior to its untimely termination in March 2014 due to an incident related to the facility's power and control systems.

The main message we took from all these entrepreneurs is that they need to have access to capital to allow their operations to achieve an economy of scale required for profitability in addition to start-up capital since the initial cost of building a RAS facility is daunting. As the global demand for fish and seafood increases, the demand for fish and seafood produced with "greener" technologies, such as RAS facilities, is likely to increase. The Committee supports the development of land-based, closed-contained technologies in niche markets for which opportunities for growth exist.

1.5.2 Closed and Semi-Closed Floating Tanks and Offshore Technologies

The Committee also heard testimony on other innovative technologies that are being tested for finfish aquaculture, including closed and semi-closed floating tanks and offshore technologies:

- Closed and semi-closed floating tanks have been tested in Canada with limited success growing finfish in both marine and freshwater environments. Research continues, however, to help find ways of improving the durability and efficiency of these technologies.

- Offshore aquaculture was presented to us as a way of optimizing environmental conditions (greater currents help continuously replenish oxygen levels within cages and disperse waste) while at the same time, minimizing conflicts with other ocean-user groups. Offshore aquaculture was also discussed as being interesting for use in very large aquaculture operations. The Committee was told that this emerging sector offers opportunity for further development in finfish aquaculture, particularly in N.B. and N.S. However, it was also indicated that offshore aquaculture raises technological issues such as the need to function in more remote and challenging environments, where operations would face greater weather events (e.g., storms) and would require employees to work in remote locations, far away from the coast. This could also require the automation of a large portion of aquaculture grow-out operations.

These emerging technologies offer potential to further develop aquaculture in Canada. Accordingly, the Committee believes that their environmental performance and their economic viability need to be further assessed.

CHAPTER 2: Legislative and Regulatory Framework

> *Sustainability, the principal goal of aquaculture governance, enables aquaculture to prosper over a long period. It entails economic viability, social licence, environmental integrity and technical feasibility. (UNFAO, 2014, p. 88)*

In Volume One and Volume Two, the Committee explained that aquaculture is typically regulated under several pieces of legislation involving many regulatory authorities and that its governance appears, by its very nature, relatively complex. This is true in Norway and Scotland, as it is in Canada. That said, national legislation governing aquaculture in Norway and Scotland ensures that companies operating in various locations within these countries are subject to a uniform and coherent set of regulations. No such national legislation currently exists in Canada.

Norwegian legislation is enabling and aims "to promote the profitability and competitiveness of the aquaculture industry within the framework of sustainable development and contribute to the creation of value on the coast."[11] While the promotion of aquaculture is not explicit in its legislation,[12] Scotland openly supports the sustainable growth of both the marine finfish and shellfish aquaculture sectors and has set production targets to reach by the year 2020. There are no production targets set by the federal government for aquaculture in Canada.

Furthermore, Norwegian legislation subjects each step of the aquaculture approval process to fixed timelines and, overall, the time limit cannot exceed 22 weeks; this process is facilitated by a one-stop-shop that coordinates the work of all the other regulatory authorities (national and local) involved in the aquaculture licence approval. In contrast, the lack of a streamlined application process is an issue often raised in Scotland and in Canada as several licences, leases, permits and approvals must be obtained separately before an aquaculture facility may operate. It is estimated that the licence application process can take between 18 months and two years in Scotland, while it can last two years or more in Canada.

2.1 Two Constitutional Realities

The involvement of different levels of government in Canada renders the governance of aquaculture more complex than in Norway and Scotland. What further complicates the situation is that the 2009 Supreme Court of British Columbia (the *Morton* decision) created two constitutional realities with respect to aquaculture within Canada.

Before 2009, the majority of aquaculture regulation was carried out at the provincial level, while the federal government used its fisheries power to regulate protections for wild fish and fish habitat that share waters with aquaculture facilities. In this way, the federal government regulated certain aspects of aquaculture indirectly. In the *Morton* decision, the court found that finfish aquaculture on the coast of B.C. is a fishery and therefore falls under federal jurisdiction. Because this decision was not appealed to the Supreme Court of Canada, the *Morton* ruling applies only in B.C. Following the *Morton* decision, the federal government drafted the *Pacific Aquaculture Regulations* (PAR) in order to assume its newly recognized role in regulating

11 Norwegian Ministry of Fisheries and Coastal Affairs, ***The Aquaculture Act***, 2005.
12 ***Aquaculture and Fisheries (Scotland) Act 2013***.

aquaculture in that province. Outside of B.C., there has been no litigation similar to *Morton*. In these provinces, the current division of responsibilities to regulate the various aspects relating to aquaculture is a product of bilateral Memoranda of Understanding (MOUs) between the federal and each provincial government.

Accordingly, the extent of the federal power to regulate aquaculture in Canada is a matter of unsettled law. Each province recognizes a different federal/provincial division of powers, depending on the MOU concluded in the province, while in B.C. the *Morton* ruling plus the federal jurisdiction asserted in the PAR prevail. There will be no nationally accepted common understanding of the federal/provincial division of powers in aquaculture until the Supreme Court of Canada rules on the matter in some future case.

Nonetheless, the Committee wants to propose a strong federal role in the regulation of aquaculture – one that would not encroach upon provincial jurisdiction as it is currently recognized in the various provinces, but that would reduce to a great extent the complexity of current federal governance and stimulate investment in aquaculture. While we understand that it is not possible to establish a clear and uniform federal regime for regulating aquaculture across the country, we strongly believe that the time has come for the federal government to assert the full extent of its recognized jurisdiction in this field.

2.2 A Federal Aquaculture Act

As explained in Volume One, the Canadian aquaculture industry is currently governed by several federal statutes administered by different departments. During the site application process, Fisheries and Oceans Canada (DFO) provides advice on the suitability of the site for aquaculture and on maximum production levels so as to minimize environmental impacts. Once a site is deemed to be suitable, the proposed aquaculture operation must be granted a number of federal authorizations prior to establishing any infrastructure or facility including, for example, an approval from Transport Canada for navigation purposes and from Environment Canada in relation to shellfish water classification. Once an aquaculture facility has obtained a federal (DFO in B.C.) or provincial (elsewhere) licence to operate and is established, its day-to-day operations are regulated by DFO (introductions and transfers, species at risk, use of deleterious substances, etc.), the Canadian Food Inspection Agency or CFIA (aquatic animal diseases, fish feed, biotoxin surveillance, etc.), and Health Canada and the Pest Management Regulatory Agency or PMRA (veterinary drugs and pest control products).

DFO is the lead federal department responsible for aquaculture management; its main piece of legislation governing aquaculture, the *Fisheries Act*, does not explicitly recognize aquaculture as a legitimate industry nor does it define it. The *Act* simply was not developed with aquaculture in mind. Although the *Act* regulates the aquaculture industry in order to protect wild fish and fish habitat – thereby fostering its environmental sustainability – it often addresses matters affecting aquaculture operations from a traditional fishery perspective that does not take into consideration the differences between wild and aquacultured stocks. The Committee learned about several examples of incongruence in the *Fisheries Act* that affect the aquaculture industry that need to be corrected, such as:

- Regulations under the *Fisheries Act* prohibit the harvesting of small oysters, as a means of protecting wild oyster populations. However, aquaculture producers grow "cocktail" oysters, which are deliberately grown to be smaller than other cultivated oysters. Harvesting small aquacultured oysters is nevertheless prohibited by the *Act*.

- Federal regulations under the *Act* also restrict harvesting seasons for wild shellfish; however, shellfish growers would like to be able to harvest their shellfish when their processors want them, which at this time is not permitted by the *Act*.
- Other regulations govern the fishing gear that must be used to harvest different wild fish species and only this specific gear can be used to catch them. Wild fish can occasionally crash into a net pen or jump into the cage, but an aquaculture operator does not necessarily have the particular fishing gear on hand to remove the wild fish from the net pen in accordance with the *Act*.

Accordingly, representatives of the aquaculture industry repeatedly told the Committee that it is important to make appropriate distinctions between the federal legal requirements that should apply to traditional fisheries, those that should apply specifically to aquaculture, and those that should apply to both. In their view, the approach taken by DFO – to treat aquaculture under fishery legislation – has caused confusion. For this reason, they called on the federal government to recognize aquaculture legislatively as a distinct and legitimate industry.

As noted above, the aquaculture industry is regulated at the federal level through other departments and agencies. The fact that these departments and agencies are involved in the management of aquaculture reflects the cross-disciplinary nature of the industry. However, the Committee heard concerns that this leads to overlap and duplication in activities associated with different federal regulations. One example given to the Committee is that aquaculture operations may require both a DFO Introduction and Transfer Licence and a CFIA permit under the National Aquatic Animal Health Program (NAAHP) to introduce or transfer finfish/shellfish to new waters. We also heard that there is duplication in monitoring and inspection activities carried out by different regulators. For example, a number of witnesses explained that the use of pest control products in grow-out sites may require inspections by the PMRA, Environment Canada, and DFO. Moreover, the Committee was told that aquaculture operations may, in certain circumstances, be given opposite guidance from different regulators. For example, the CFIA could order an aquaculture operation to cull the fish at its grow-out site according to the NAAHP, which could include by-catch, and DFO could issue a by-catch charge to the operator for complying with the cull ordered by the CFIA.

Furthermore, the scattering of provisions that pertain to aquaculture throughout a plethora of legislation and regulations makes it difficult to understand the federal role, as well as to develop a unified, uniform, comprehensive federal approach to aquaculture. In our view, maintaining the *status quo* in the federal governance of aquaculture is not a viable option.

Accordingly, we believe that it is imperative that new federal aquaculture legislation be enacted. Several other reasons justify our support for a federal aquaculture Act:

- A new Act would recognize aquaculture as a legitimate industry in Canada at the national level.
- A new Act would allow the federal government to state, in legislation, its intent with respect to aquaculture and clarify its role with respect to this industry.
- A new Act would, in one document, explain how aquaculture is managed at the federal level. This would increase public confidence in the environmental sustainability of aquaculture and in the government's ability and intent

to manage the sector effectively, efficiently and sustainably.

- Under a new Act, aquaculture would be a distinct area of public policy and would be given a higher profile than is now the case.
- A new Act would signal that the federal government is serious about aquaculture and accords the industry high recognition in its priorities. This signal would increase the confidence of investors (both Canadian and foreign) in the industry, allowing for enhanced private sector financing of industry expansion in this country.
- A new Act would provide more comprehensive mechanisms to encourage industry development while ensuring regulatory compliance.

During the hearings, several representatives of the industry insisted that they are "fish farmers" and that aquaculture is a farming activity or the aquatic form of agriculture. Like agriculture (and unlike commercial capture fisheries), aquaculture implies some form of ownership of the stocks being cultivated. The main difference between aquaculture and agriculture, in most cases, is the environment in which such activities take place – in bodies of water for the former and on land for the latter. Moreover, most aquaculture takes place in public waters, whereas agriculture usually takes place on private property. Some witnesses explained that, while it is accepted that agriculture removes the natural ecosystem and replaces it with fields either for forage or for crops, the opposite occurs in aquaculture: grow-out operations are undertaken in ways that do not permanently alter the ecosystem.

In New Brunswick, the Committee visited the St. Andrews Biological Station (SABS). Founded in 1908, the SABS is the oldest marine research facility in Atlantic Canada. In 2012, the station completed a major renovation and opened a science building and a wet laboratory that includes holding tanks and a bio-containment facility for research on live aquatic animals. Research conducted at the station helps inform DFO's regulatory mandate.

Photo courtesy of: Fisheries and Oceans Canada.

It is, after all, public property. This distinction is fundamental to us. Overall, it appears that aquaculture is not aligned with being a fishery, but it is not an agricultural activity either. In the Committee's opinion, it is something different: aquaculture is aquaculture and it deserves its own recognition.

Who then should be responsible for the administration of the federal aquaculture Act? DFO has been the lead federal department for aquaculture management for over 30 years. This responsibility was first assigned to the Department by the Prime Minister in 1984 and was reaffirmed over the years by successive governments. The Committee believes that DFO should continue its lead role. We further believe that the Department has developed the expertise by taking over the responsibility for the overall regulation of aquaculture in B.C. and is best suited to develop and administer the new Act.

Perhaps more importantly, what should be contained in the federal aquaculture Act? It is the view of the Committee that the Act must legitimize the aquaculture industry and acknowledge its important economic contribution to various regions of the country, including several Aboriginal communities. The Act must also encourage the sustainable growth of the industry. In addition, the new Act must consolidate the already existing aquaculture-related regulations (such as the PAR and the proposed Aquaculture Activities Regulations or AAR). The new statute should also include a federal veto on aquaculture development at any site in order to prevent a particularly high-risk situation for wild fish and fish habitat; this would minimize the risk of approving the development of an aquaculture site in a potentially unsuitable location. In coming to an opinion regarding risk, the Minister should be required to consider scientific information and Aboriginal traditional knowledge. The Committee further believes that the Act should lead to the creation of a new administrative body within DFO that would coordinate the activities of all federal regulatory authorities involved in aquaculture; this one-stop-shop would solve the problems of duplication, overlap, contradiction, cumbersomeness, lack of clarity, and inconsistency inherent to the current federal regime. Moreover, the Act should establish timelines, similar to those set in Norwegian legislation, for each step of the review process leading to the various federal aquaculture authorizations. Finally, some non-regulatory items could be included in relation to aquaculture statistics and public reporting on aquaculture operations across the country; this would help improve the aquaculture industry's social acceptance.

Accordingly, the Committee recommends:

1. **That Fisheries and Oceans Canada introduce a federal aquaculture Act that responds to the concerns voiced during the Committee study and that asserts the full extent of federal jurisdiction. The Committee further recommends that the Act include the following:**

- **a strong preamble that expresses federal support for the orderly expansion of an environmentally, economically, and socially sustainable aquaculture industry and that recognizes the important economic contribution of the industry in remote, rural, and coastal communities across the country, including First Nations;**
- **a consolidation of existing and proposed federal regulations governing aquaculture currently under the *Fisheries Act*;**

- **an explicit power for the Minister of Fisheries and Oceans to veto any proposed aquaculture site that, in the Minister's opinion, poses an unacceptable risk of harm to wild fish or fish habitat, or other environmental risks;**
- **a new administration housed within Fisheries and Oceans Canada charged with the coordination of the federal regulatory role in aquaculture. The new administration should be a one-stop shop responsible for all federal functions in aquaculture – including those of the Canadian Food Inspection Agency, Environment Canada, Transport Canada, Fisheries and Oceans Canada and others – to ensure a streamlined and efficient regulatory regime for aquaculture;**
- **timelines for the diverse federal decisions on aquaculture authorizations; and**
- **non-regulatory provisions in relation to aquaculture statistics and public reporting on the operation of the industry.**

The Northwest Atlantic Fisheries Centre (NAFC) is the regional headquarters for DFO's Newfoundland and Labrador Region. The NAFC consists of marine and freshwater aquaria, a stream tank, toxicity laboratories, wet labs, an open seawater system, as well as electronic, vessel, computer, oceanographic, diving, and library support. While at the NAFC, the Committee was given a tour of the facilities and was provided a brief presentation on research activities carried out at the NAFC.

Photo courtesy of: Fisheries and Oceans Canada.

2.3 Federal and Provincial Collaboration

As noted above, the specific division of roles and responsibilities in aquaculture carried out at the federal and provincial levels varies in Canada as a result of the *Morton* decision in B.C. and also because the federal government has signed MOUs with the other provinces. The Committee often heard during fact-finding missions across the country that the level of duplication and confusion and the lack of uniformity in aquaculture governance are compounded when considered from a federal/provincial perspective. It was explained that duplication could be reduced through the sharing of information between provincial and federal departments/agencies as well as the establishment of equivalent programs whereby, for example, samples taken for monitoring and compliance purposes could be tested locally for both levels of government.

These bilateral MOUs between the federal government and the provinces were signed in the late 1980s, when the aquaculture industry began establishing operations in Canada. In B.C., the MOU between the two levels of government was revised in 2010, following the *Morton* decision. The Committee believes that it is time for the federal government to modernize the various MOUs with each individual province. Revisions could be made in light of the new federal aquaculture Act while at the same time identify areas for harmonization of the regulatory and policy framework to ensure that federal and provincial regulatory activities are coordinated and coherent.

During the hearings, the Committee also learned that the Canadian Council of Fisheries and Aquaculture Ministers (CCFAM) is currently working to address a number of challenges associated with Canadian aquaculture governance. This work is carried out as part of the National Aquaculture Strategic Action Plan Initiative (NASAPI), a five-year initiative launched in 2010 to ensure the sustainable development of the aquaculture industry in Canada.[13] With respect to governance, it was agreed that NASAPI would: 1) develop consolidated environmental management frameworks based on sound scientific protocols in support of a streamlined and harmonized aquaculture site application and review process; 2) review and renew national policies and guidelines for aquaculture site applications under the *Navigation Protection Act*; 3) review federal and provincial on-site inspection requirements for each class of aquaculture operations and establish procedures to streamline and harmonize inspection and reporting protocols; and 4) address other regulatory and governance issues pertinent to sustainable aquaculture development, including clarifying the rights and obligations of aquaculture operators located in public waters and addressing matters that unduly hinder operational efficiency.

The Committee was told that NASAPI was an ambitious plan. A number of important tasks were completed under NASAPI, including the renewal of the National Code on Introductions and Transfers of Aquatic Organisms and modernization of the Canadian Shellfish Sanitation Program (CSSP). It was also a success in terms of coordination amongst the federal and provincial governments. Furthermore, it was stressed that the work undertaken under NASAPI is important and should continue (the initiative comes to an end in 2015).

Although the Committee concurs with witnesses that some important tasks were accomplished under NASAPI, it is very disappointing to see how

13 NASAPI, ***Overarching Document***, an initiative of the CCFAM, 2010.

little progress has been achieved in the area of aquaculture governance. Five years after its launch, NASAPI has not delivered on one of the major impediments to the growth of the industry in Canada, namely the lack of uniformity in federal/provincial aquaculture governance across the country. That said, we believe that the governance structure afforded by the CCFAM is very important since it ensures that provincial perspectives and priorities are respected and, for this reason, NASAPI's timeframe should be extended. An extended NASAPI however should be less ambitious and much more focussed. A number of concerns raised repeatedly during the hearings could be given priority, including, for example, the lengthy site application and review process, the lack of uniformity from one province to another in the duration of the various licences, leases and other approvals needed to run aquaculture operations, and matters that hinder operational efficiency (such as the requirement to obtain approval to change the size of net, the orientation of the cage or the placement of monitoring equipment).

For these reasons, the Committee recommends:

2. **That Fisheries and Oceans Canada renegotiate existing bilateral Memoranda of Understanding on Aquaculture Management within 18 months of the coming into force of the new federal aquaculture Act to accelerate harmonization and reduce duplication; and**

   That the National Aquaculture Strategic Action Plan Initiative be extended for another two-year term and be mandated to complete work on national consistency and simplicity in aquaculture regulation.

The Newfoundland and Labrador Department of Fisheries and Aquaculture regulates the aquaculture industry in the province, promotes its growth and development, supports aquaculture research, and plays a role in the coordination of aquaculture efforts in the province. While in St. John's, the Committee met with NL-DFA representatives to discuss the new provincial aquaculture strategy, with a particular focus on its identified research priorities.

CHAPTER 3: Healthy Aquacultured Fish[14]

The Committee repeatedly heard during the study that fish health should be the number one priority of all aquaculture operations. Healthy aquacultured fish are crucial to the productivity, profitability, and competitiveness of the industry on the domestic and international markets. Furthermore, rearing healthy fish stocks contributes to eliminating or reducing the environmental impacts of aquaculture, thereby improving the industry's reputation. After all, healthy aquacultured fish never or very rarely require drugs or pest control treatments, and have the lowest mortality rates in the industry. We were told that aquaculture producers provide the best care for the fish they raise through the adoption and use of science-based operating practices that span prevention to intervention.

In the field of fish health, DFO works closely with the CFIA under the NAAHP to protect aquatic animals and prevent the introduction and spread of disease in wild and aquacultured fish. While the CFIA has the lead role in managing diseases listed in the *Health of Animals Act*, DFO plays a key role through science and research, its extensive sampling and monitoring programs and, in B.C., conditions of licence related to fish health. These conditions require each site to have a fish health management plan which affects all aquaculture operating practices that can impact the health of fish on site and, by extension, minimize potential impacts on wild fish and the ecosystem. They include protocols for keeping fish healthy, as well as regular sampling, monitoring, record keeping, and reporting.

3.1 Fish are Introduced to Grow-out Sites Healthy

It was explained to the Committee that fish are introduced into aquaculture grow-out sites disease- and parasite-free. As a first step, all the eggs produced come from parents that have been screened for all the diseases common to wild fish. Then, in the hatchery – where they spend about a year of their life – fish continue to be screened for these diseases. Additionally, prior to their transfer to grow-out sites, every fish is vaccinated against some of these diseases. Once in the net cages, their general health is monitored daily, and assessments for bacteria, viruses and parasites are carried out on a weekly basis. In addition to in-house assessments, sampling is conducted by DFO and the CFIA as part of the NAAHP, as well as by independent laboratories.

The Committee was told that a variety of preventive measures are taken to keep aquacultured fish healthy, including:

- Location: During the site approval process, a risk assessment of disease spread in the proposed aquaculture site and its surrounding environment is conducted. This assessment aims to identify risk factors that may compromise the health and welfare of the fish, including: the general disease situation surrounding the location selected, proximity to other grow-out sites and rivers, species to be raised, and production volumes. Certain locations may have biophysical conditions that make them unsuitable to grow particular species, but suitable to grow others.

14 During the hearings, issues related to fish health were raised primarily in relation to marine salmon aquaculture. For this reason, this chapter focuses mainly on the health of salmon aquaculture stocks.

- Licence Conditions: Once a suitable location has been identified, the licence issued contains the maximum biomass that is allowed at the site. The Committee was told that maintaining appropriate stocking densities reduces stress on the fish, which promotes better fish health. As per the licence conditions, aquaculture producers are also required to develop fish health management plans and to participate in government health audits.

- Biosecurity Measures: These measures aim to prevent the introduction of any pathogen into an aquaculture operation. Disinfection of nets and other equipment constitutes one example of a biosecurity measure used to eliminate potential pathogenic organisms. Another biosecurity measure mentioned was the practice of delivering feed to juveniles before older fish. The Committee also learned about the biosecure inflow and outflow wharves in N.L. The inflow wharf is used to send the new fish (the smolt) to the marine aquaculture sites. The other wharves are designated for the outflow material – fouled nets, dead fish, and harvested fish. It was explained to us that using these different wharves to maintain a separation between inflow and outflow activities helps reduce the risk of cross-contamination if a disease outbreak were to occur.

- Bay Management Areas (BMAs): BMAs have been established in several jurisdictions in Canada (and more recently in Scotland) in response to the expansion of the aquaculture industry with the precise aim of preventing and reducing the impact of disease and parasites.[15] BMAs usually set a minimum distance between sites operated by the same company and another minimum distance between sites operated by different companies. BMAs identify zones in which aquaculture producers must synchronize their operations, including stocking, harvesting, and fallowing. Stocking requires year-class separation (only one generation of fish on a site at a time); it was explained that requiring a single-year class of fish within each BMA prevents older fish, that may have already been exposed to a parasite or disease present in the environment, from transferring it to smolt. Fallowing is the process whereby grow-out sites are left empty for a period of time to recover following harvesting.

The Committee heard that vaccination against diseases plays a key role in ensuring the sustainability of the aquaculture industry. We were told that the use of vaccines, combined with biosecurity measures, has led to a reduction in the use of antibiotics and allowed growth in aquaculture production over the years. The effectiveness of vaccination was discussed in relation to Infectious Hematopoietic Necrosis (IHN). An important outbreak of IHN occurred from 2001 to 2003 among 36 Atlantic salmon production sites in B.C. Since then, the only IHN outbreak occurred in 2012; it was confined to three sites, spanning three months, thanks in part to a vaccine developed and now used for all aquacultured Atlantic salmon. It is believed that if use of such a vaccine continues, B.C. may never again see another IHN outbreak among its aquaculture sites.

Similarly, the Committee was told that BMAs have been highly effective in N.B. and Scotland in containing outbreaks of Infectious Salmon

15 BMAs have not been implemented in Norway due to the industry's structure and the different sizes of aquaculture companies – small, medium and large – making it difficult to establish them.

Anaemia (ISA), for which there are no treatments or vaccines. We learned that ISA was a continual challenge between 1996 and 2006 in the Bay of Fundy, but that there have been no confirmed cases of ISA in the region since the fall of 2006 as a result of the establishment of BMAs, along with enhanced detection efforts and biosecurity measures. In Scotland, ISA is considered a significant but occasional problem; the last outbreak occurred in 2008 and was confined to a small area; the fish were removed quickly to reduce the spread of disease.

Overall, the Committee was told that Atlantic salmon produced in Canada are very healthy: on average, 90% of aquacultured fish survive in salmon grow-out sites.

3.2 How Do Aquacultured Fish Get Sick and Get Treated?

The introduction of pathogens in grow-out sites appears to be related to the level of infectious agents in the surrounding environment. The source of a pathogen may be an infected wild fish or contaminated equipment. The Committee was told that high stocking densities in grow-out sites predisposes aquacultured fish to pathogens and the close proximity of the fish facilitates their transmission. Aquaculture sites are also considered to be a potential reservoir for re-transmission of pathogens to wild fish. For these reasons, aquaculture operators require access to chemotherapeutants to minimize the impact of these pathogens. The Committee was told that

The Atlantic Veterinary College (AVC) of Prince Edward Island University is one of five veterinary colleges in Canada. In addition to its academic programs, the College undertakes various research projects in relation to both finfish and shellfish aquaculture. The AVC houses the Centre for Aquatic Health Sciences (CAHS), a world-class academic centre of expertise in finfish health research, which was toured by the Committee. Current aquaculture research undertaken at the CAHS relates, among others, to sea lice management.

Photo courtesy of: Atlantic Veterinary College, UPEI.

chemotherapeutants are classified as either a drug or a pest control product based upon their application method. Generally, products applied topically or directly into the water are considered pest control products, while products delivered through medicated feed or by injection are considered drugs.

3.2.1 Sea Lice Infestations

It was explained to the Committee that sea lice are small external parasitic crustaceans that latch onto salmonids and other marine fish species. They inflict damage both directly (by feeding on the host's body) and indirectly (by making the host more vulnerable to secondary infections). In Canada, there are different species of sea lice. We were told that sea lice on the West Coast are not nearly as pathogenic as on the East Coast and that, generally, Atlantic salmon appear to be more susceptible to sea lice infestation than Pacific salmon species (pink, coho, chum and sockeye).

It was further explained that sea lice have eight life stages and that they attach themselves to fish while in their third life stage. Water salinity and temperature, as well as water movement (from tides and currents), influence their development and survival. Sea lice reproduce year-round, but reproduction increases quickly as water temperatures rise. The Committee was told that, since each aquaculture region has a unique combination of biophysical characteristics, the life cycle and dynamics of sea lice vary from one region to another. For example, winter water temperatures on the West Coast do not significantly hinder sea lice development, but East Coast winter water temperatures can significantly slow or stop their development. Sea lice do not survive in fresh water.

Several witnesses indicated that sea lice are an ongoing concern for the industry worldwide and require constant management and control. In their view, integrated pest management is required to ensure the long-term sustainability of the salmon aquaculture sector. Fallowing can be used as a control measure for sea lice; by removing the hosts from the immediate area, the number of sea lice around the site declines. Usually, fallowing is synchronized with all the other grow-out sites in a particular area to increase its effectiveness.

The Committee learned that there is only one veterinary drug available to manage sea lice infestations in Canada – SLICE®. The drug is delivered as a coating on feed which is then eaten by salmon, metabolized and subsequently circulated to its tissues. Sea lice feeding on the salmon's tissue (skin, fins and/or gills) ingest the drug and SLICE® acts as a neuroblocker, which results in paralysis and ultimately the death of the parasite. The Committee was told that the use of SLICE® as the only method of sea lice management has led to drug resistance in Norway and Scotland, as well as in some regions within Canada (particularly in N.B.).

In addition to SLICE®, aquaculture companies in Canada have access to two pest control products, Paramove® and Salmosan®, which are applied through bath treatments. The Committee learned that bath treatments can be administered directly on site by using tarpaulins as skirts (draped around each cage) or completely closed tarpaulin systems (pulled under the cage to provide a complete enclosure) to create a temporary containment while the pest control product is applied (which increases its effectiveness at lower concentrations). Bath treatments can also be provided in well-boats, where fish are transferred from their net cage into the boat where they are being treated, and then transferred back to the cage after the treatment. We also learned that after the treatment the product is allowed to disperse into the surrounding water (no matter how the treatment is administered).

The potential for declining effectiveness of SLICE®, the desire to limit reliance on chemotherapeutants, and the move towards more effective integrated pest management plans in recent years have encouraged the research into and the development of non-chemical, biological and green technologies to manage sea lice, including the following:

- Cleaner-fish: They use their specialized mouthparts to detach lice and other parasites from fish. There is a considerable history in Norway of wrasse (a species of cleaner-fish) being successfully used in commercial production cycles. Another species of cleaner-fish, the lumpsucker, is also subject to trials in Scotland as it seems to perform better than wrasse in colder temperatures. In Canada (N.B. and N.L.), certain species of cleaner-fish – the cunner and the lumpfish – are also at various trial stages; one company is presently building a broodstock program at the Huntsman Marine Science Centre so that it does not have to rely on wild cunner in the future.
- Snorkel cage: Scotland and Norway have experimented with the use of snorkel cages to avoid sea lice infestations. Sea lice primarily live at shallow depths and, accordingly, it is possible to establish a lice-free zone where the aquacultured salmon can still thrive. To establish this zone, a net roof is placed to hold salmon deeper than the parasite-risky surface layer. A central cylindrical passage, the snorkel, which is impermeable to parasites, allows salmon to swim to a shallower portion of the water column, where oxygen is more abundant. The experiment showed that the snorkel cages reduced sea lice infestations compared to traditional cages.
- Bi-culture and IMTA: Field trials are taking place in Canada, both on the East and West coasts, to investigate whether filter-feeding shellfish (more particularly mussels and oysters) suspended at salmon grow-out sites might reduce sea lice infestations and the need for drugs and pest control products if bivalves consume sufficient quantities of sea lice larvae from the water column. These field trials are undertaken by the Canadian Integrated Multi-Trophic Aquaculture Network (CIMTAN).
- Mechanical removal: The Committee toured a research facility in Atlantic Canada that is piloting a system that mechanically removes sea lice; salmon are pumped into a cylinder where sea lice are removed by water jets.
- Genomics: The Committee learned that some species of Atlantic salmon have been found to carry lower sea lice levels than others, which has led to an interest in selective breeding for the development of species with increased sea lice resistance. This research has been conducted by Genome Canada.
- Bigger smolt: The possibility of growing smolt to a bigger size (up to 1 kg) in land-based closed RAS is being studied in Norway and Scotland with the view of shortening the period of time spent in marine grow-out cages, thereby reducing the risk of exposure to parasites and other pathogens (and reducing escapes).

According to research, non-chemical approaches to sea lice management may not be as effective as drugs and pest control products when used individually, but they could ultimately be part of an effective integrated sea lice management strategy and prevent Canada from experiencing sea lice with increased resistance to treatment as is the

case in Norway, in addition to being safer for the environment.[16]

The Norwegian government enforces strict rules on sea lice. For example, regulations authorize a 5% increase in biomass only when operators can maintain sea lice levels at a certain threshold while using a maximum of two treatments per production cycle. Prompt reduction in biomass at any given site may be ordered and, if necessary, slaughtering of all the fish in a given site where operators are found unable to maintain the sea lice levels under the maximum allowable levels. Other rules may mandate an extension to the fallowing period, a ban against new smolt entries, or a ban against the use of a specific treatment where resistance has been documented. These stricter requirements are accompanied by increased monitoring and the possibility of sanctions. Another option being considered to minimize the spread of sea lice between cages is the establishment of a minimum distance between different grow-out sites (an approach already in use in Canada).

The Committee believes that there are lessons to be learned from Norway's experience. In particular, the Canadian aquaculture industry must continue to use minimum distances between sites to prevent the spread of infestations from one grow-out site to another. In addition, research into sea lice epidemiology and the effectiveness of non-chemical methods needs to continue. More importantly, the use of proven effective non-chemical methods must be encouraged and the use of drugs and pest control products reserved for occasional use.

3.2.2 Infectious Salmon Anaemia

As previously indicated, ISA is an infectious disease present in the natural environment affecting both aquacultured and wild finfish with certain strains of the virus causing disease and others not. The Committee was told that, depending on the virus strain, outbreaks of ISA can cause death rates of up to 90% in affected finfish populations, and finfish aquaculture sites are known to be more at risk of spreading the virus rapidly due to their denser populations, therefore increasing the likelihood of an ISA outbreak. Since there are no treatment options currently available for ISA and no vaccines against the disease have been developed, aquaculture operations are very vigilant in monitoring the presence of this disease.

Since 1996, ISA has been confirmed in N.B., N.S., P.E.I. and N.L. No case of ISA has ever been confirmed by the CFIA in B.C., in either aquacultured or wild finfish, although it should be noted that certain researchers who appeared before the Committee insisted that ISA has been detected in the province.

N.B. has been able to control the virulent strain of the disease and, as a result of increased biosecurity protocols and the introduction of BMAs, there have been very few confirmed cases of ISA in the province since the fall of 2006. Moreover, management practices are ongoing to ensure that this remains the case. For example, as a best management practice, industry quickly and voluntarily harvests stocks that are suspected to be infected with ISA – often prior to the CFIA confirming the diagnosis – to mitigate the outbreak potential to both neighbouring aquaculture sites and wild stocks.

16 Fisheries and Oceans Canada, ***Sea Lice Monitoring and Non-Chemical Measures***, Canadian Science Advisory Secretariat, July 2014.

In Scotland, the Committee was told by government and industry representatives that ISA is a significant but occasional problem (in contrast to sea lice, which is a constant problem). It was explained that there is a strict ISA eradication policy in place in Scotland, which includes the slaughtering of suspected infected stocks, like in N.B.

The Committee was also told that the aquaculture industry has faced a number of other fish health challenges in the past few years and that this has highlighted the need to foster fish health-related research and development (R-D) into areas such as vaccine development and biosecurity measures.

3.2.3 Access to Drugs and Pest Control Products

A constraint often mentioned by industry and provincial government representatives related to the lack of access to aquatic animal drugs and pest control products in Canada, which limits the effectiveness of their integrated fish health/pest management plans. They stressed that collaborative efforts are required to engage Health Canada, both its Veterinary Drug Directorate and the PMRA, DFO and Environment Canada toward a responsible and efficient approval process for aquatic animal drugs and pest control products in line with international aquatic animal health standards, more particularly the minor use minor species (MUMS) template. "Minor uses" refers to small-scale (limited or infrequent) use of chemotherapeutants in animals, while "minor species" refers to food-producing species other than cattle, chicken, turkey, lamb, and the like. Scarcity of MUMS products in Canada occurs, in part, because the markets for these products are too small to enable drug manufacturers to recoup the fixed costs associated with drug development, approval, and sale. Classifying an aquatic animal product as MUMS would reduce the cost associated with its registration/approval and would allow for the fast-tracking of the product, while still ensuring its safety.

Overall, Canadian aquaculture producers do not have access to the same range of pest control products and veterinary drugs as producers in other countries, including Norway and Scotland, and are therefore at a disadvantage on global markets. Fish health is the foundation of the aquaculture industry and, for this reason, the Canadian aquaculture industry must be given improved and timely access to a range of drugs and pest control products. Therefore, the Committee recommends:

3. **That Fisheries and Oceans Canada develop and establish with Health Canada and the Pest Management Regulatory Agency a Minor Use, Minor Species Program for Aquaculture.**

Newer, more environmentally friendly and more efficient products will be made available to Canadian producers, which will help level the playing field and allow them to be more competitive in global markets.

3.3 Fish Feed

Finfish held in aquaculture operations are fed with special pellets designed to meet their nutritional requirements and allow for optimal health and growth. The Committee learned that fish feed accounts for about 60% of the cost of growing fish and is therefore a significant factor in the financial viability of an aquaculture operation. We were also told that the aquatic feed sector is working to develop more efficient and effective diets using a larger array of agriculture-based inputs while reducing the proportion of fish meals and oils.

Schedule 5 of the regulations developed pursuant to the federal *Feeds Act*, which is administered by the CFIA, lists the additives or nutrients that can be used in fish feed formulations. The Committee was told that a number of feed additives which are not approved for use in the formulation of fish feed in Canada are permitted in other countries, including

Norway and Scotland. Fish that have been fed using these ingredients can be imported into the country, which, in the view of several witnesses, makes little sense. In addition, some of these feed additives stimulate the immune system and increase the resistance of salmon to sea lice infestations.

The Committee concurs with witnesses that there is some incoherence in federal aquaculture governance. In our view, the current regulations governing fish feed additives stifle innovation for development of improved diets and impede the industry's global competitiveness. Accordingly, the Committee recommends:

4. **That the Canadian Food Inspection Agency revise Schedule 5 of the regulations under the *Feeds Act* to include a wider range of additives or ingredients for use in the formulation of fish feed.**

3.4 Shellfish Health

The CSSP is a federal food safety program jointly administered by the CFIA, Environment Canada and DFO. The goal of the program is to protect Canadians from the health risks associated with the consumption of contaminated shellfish. As part of the CSSP, Environment Canada monitors water quality in shellfish harvesting areas across Canada to ensure that water is exempt from contaminants and that shellfish produced is safe for human consumption.

As part of the program, all shellfish harvesting areas are required to have regular water sampling performed on their sites for such things as faecal coliforms, chemicals, and other contaminants. Limited resources on the East Coast have meant that only certain areas at a time can be sampled; the Committee was told that this situation has hindered expansion of the shellfish aquaculture sector in the region. In N.L., testing is no longer carried out in the province; all samples must be sent to Dartmouth and aquaculture operators must wait for the results. The Committee was also told that there are currently no resources for testing water quality of proposed shellfish aquaculture sites in N.S., unless companies bear the cost of water sampling/testing themselves, rather than waiting for the service to be performed and paid for by Environment Canada.

The Committee believes that the CSSP must be modernized to make it more responsive to the needs of aquaculture shellfish growers. The growth of this segment of the industry depends on timely access to CSSP's water testing services. We further believe that alternative methods to CSSP's current water sampling monitoring program should be explored, including, for example, the use of authorized or certified private third parties.

The Committee also learned that several shellfish aquaculture operations on the East and West Coasts are afflicted by aquatic invasive species (AIS), such as the green crab, clubbed tunicate and vase tunicate. Some of these AIS prey directly on the cultured shellfish, while others out-compete them for habitat and resources. AIS affect growth and meat yield and cause increased maintenance and labour costs for growers and processors. The Committee was told that, once an invasive species has become established in an area, it becomes essential to develop innovative technologies and practices to effectively manage it. It is especially important to initiate a rapid response in the early stages of invasion. Accordingly, the Committee recommends:

5. **That Fisheries and Oceans Canada work with the provinces and the aquaculture industry to evaluate, within the next two years, new technologies and methods for the effective management of aquatic invasive species in the shellfish aquaculture sector.**

CHAPTER 4: Healthy and Productive Ecosystems

> *I say to anyone who opposes aquaculture that some of the best stewards of the ocean are people who are involved in this industry, because we make our living every day on the ocean. So we certainly don't want to cause problems. We want to make sure it's a sustainable industry that's around for many generations to come. Terry Ennis, President and CEO, Atlantic Aqua Farms (21:25)*

Aquaculture is dependent on clean, healthy and productive waters. Industry compliance – with rigorous legislation, regulations, licence conditions, and codes of good practices – is a prerequisite to sustainable aquaculture. It is the view of the Committee that environmental protection and the maintenance of high quality aquatic ecosystems are core principles in realizing the potential of Canada's aquaculture industry in the next ten years.

4.1 Impact of Marine Finfish Aquaculture on the Benthic Environment

It was explained to the Committee that, during the functioning of marine finfish aquaculture operations, organic material is released into the surrounding waters. This organic material is the result of excess fish feed, faecal matter, and other excretion products, as well as drug and pest control products and anti-fouling treatments. Some of this material settles on the seabed at or near the cage sites where it can accumulate, while some is dispersed into the water column, spreading the wasted organic matter beyond the perimeter of the aquaculture site. Accordingly, aquaculture operations generate both near-field (localized) and far-field (distant) effects.

DFO documents indicate that the near-field effects of marine finfish aquaculture have been well studied and are the ones most frequently assessed in environmental monitoring, (primarily because they are more amenable to evaluation) and assessment is done through the collection of bottom grab samples (for soft bottom substrates) and video surveys (for hard bottom substrates). Far-field effects take longer to develop and are more difficult to detect. They are also less understood, primarily because they are often the result of many stressors (e.g., municipal or industrial wastes, agriculture runoffs, and more) and estimating the relative contribution of aquaculture as one of many environmental stressors is difficult.[17]

Government and industry representatives, as well as many researchers, who testified before the Committee, acknowledged that organic matter from aquaculture operations sinks to the bottom. They also recognized that if sufficient material accumulates on the seabed, the physical, chemical and biological composition and structure of the bottom habitat in close proximity to aquaculture operations could be affected. They noted, however, that changes to the environment from organic matter accumulation are rarely permanent and explained to us that once the excess of organic loading ceases, the benthos recovers naturally to background levels. Fallowing (the act of leaving the site empty for a time) is therefore practised in

17 D.J. Wildish, M. Dowd, T.F. Sutherland and C.D. Levings, ***Near-Field Organic Enrichment from Marine Finfish Aquaculture***, Canadian Technical Report of Fisheries and Aquatic Sciences, Vol. 3, DFO, 2004; B.T. Hargrave, ***Far-Field Environmental Effects of Marine Finfish Aquaculture***, Canadian Technical Report of Fisheries and Aquatic Sciences, Vol. 1, DFO, 2003.

all jurisdictions; the length of time for recovery depends on the local environmental conditions such as temperature, season, hydrography, flushing, bottom type, underwater depth and other characteristics of the ecosystem. More importantly, through siting and licensing requirements, the various regulatory bodies in Canada have put in place mitigation measures, such as a maximum allowable biomass, to ensure that the release of organic material does not harm fish and fish habitat.

It was explained to the Committee that, as part of their siting processes, aquaculture operations are required to undertake their own on-site investigations to identify the presence of environmental features occurring in the general area of the application (ecological reserves, marine protected areas, salmonid bearing streams, migratory routes, etc.). Then, as part of their licence application, aquaculture operations must provide the results of habitat assessment surveys completed with the DEPOMOD software, which is the aquaculture waste prediction model recommended by DFO. Predictive levels of organic deposition provided by DEPOMOD and baseline surveys of habitat are used by regulators of all provinces when authorizing new aquaculture sites in order to avoid sensitive habitats (DFO provides scientific opinions and advice to provincial governments for decision-making). Based on this information, thresholds are placed in each licence to limit the intensity and/or duration of organic matter accumulation to ensure that any sea bed changes are minor enough that ecosystem capacity and function are not seriously harmed. This seemingly long and rigorous siting process is in place to help ensure that due consideration is given to benthic impacts and that each licence includes an appropriate deposition limit.

The conditions of licence for marine finfish aquaculture in all provinces further require operators to monitor their sites on a regular basis. All industry-generated reports and video data are assessed by regulators for compliance with licence conditions; failure to comply can lead to sanctions. In addition to the monitoring and reporting required of licence holders, regulators conduct field audits to collect and assess sediment samples and video data. These audits fulfil four purposes:

- To compare industry-generated data with those obtained by the regulators to ensure procedures are being followed correctly and that there is correlation between the two data sets;
- To determine if the appropriate compliance sampling stations or transects are being utilized by industry;
- To investigate sites with poor environmental performance or issues with compliance; and
- To learn more about benthic impacts during different periods of production and the site recovery cycle.

Compliance levels for soft-bottom sites are based on the level of sulphides in a given sediment sample. For hard-bottom sites (like in N.L. and some sites in B.C.), benthic compliance thresholds are set based on the visual presence of a polychaete (a worm) and *Beggiatoa* (a bacterium). If an operation does not stay within the set limits, the regulator may require that the site be fallowed until further monitoring shows that sufficient recovery of the benthos has occurred. Additional measures may be required to reduce future accumulation of organic matter, such as: delaying restocking, changing the layout of containment structures on the grow-out site, and changes in stocking densities or feeding methods. In severe cases, sites can be relocated.

Research conducted in Canada[18] and Norway[19] suggests that aquaculture has a low impact on the benthic environment. However, the Committee received evidence and heard testimony from citizens, groups and organizations concerned with the impact aquaculture has had on the benthic environment. In certain cases, aquaculture activities have been found to alter the benthic environment near their grow-out sites and the mandatory fallowing periods were not sufficient to eliminate these effects.[20] In one example, results showed that the recovery of the benthos in the vicinity of the soft-bottom substrate grow-out site in question was incomplete after two years of fallowing. In such cases, it begs the question, "why?" Answers can include, but are not limited to: best practices not being followed by the operator (in which case immediate measures are to be taken by the responsible regulatory authority); the site not being suitable for aquaculture activities (in which case, the licence should be revoked; such a situation is unlikely to happen in the future with a federal veto on aquaculture development); changes in the environmental conditions since the issuance of the licence/lease, such as water temperature or flow (in which case the licence and/or conditions should be revised or relocation should be considered). Regardless of the reasons why, the Committee believes that the long-term alteration of the benthic environment is unacceptable and action should have been taken to remedy the situation without delay once monitoring showed that the threshold had been exceeded. These cases not only hurt the surrounding environment, but also the reputation of the aquaculture operations in the area that are not causing such damage to the benthic environment (if not the reputation of the whole industry).

On a more positive note, it is important to acknowledge that DFO's proposed AAR will require marine finfish operators across Canada to monitor the level of sulphides according to specific bottom sampling requirements on a regular basis. If the benthos exceeds the threshold, remedial actions will need to be taken. Failure to comply with the regulations or to take remedial action will result in fine or imprisonment. Moreover, DFO will use the data generated as required by the proposed AAR to review and update, if necessary, the monitoring approach and the thresholds.

Some witnesses expressed that aquaculture environmental monitoring in Canada places too much emphasis on bottom sediments and not enough attention is devoted to sediments suspended in the water column and further reaching deposition. Their position is consistent with the scientific literature review that suggests gaps in our knowledge of the far-field environmental effects of marine finfish aquaculture. The potential environmental interactions associated with aquaculture operations in the far-field mentioned

18 DFO, ***Organic Material and its Management*** [accessed 17 April 2015].

19 Geir Lasse Taranger *et al.*, "**Risk Assessment of the Environmental Impact of Norwegian Atlantic Salmon Farming**", *ICES Journal of Marine Science*, 2 September 2014; and Vivian Husa, Tina Kutti, Arne Ervik, Kjersti Sjøtun, Pia Kupka Hansen and Jan Aure, "**Regional Impact from Finfish Farming in an Intensive Production Area (Hardangerfjord, Norway)**," *Marine Biology Research*, Volume 10, Issue 3, 2014, pp. 241–252.

20 In this regard, three research papers were tabled with the Committee: Ronald H. Loucks, Ruth E. Smith, Clyde V. Fisher, and E. Brian Fisher, "**Copper in the Sediment and Sea Surface Microlayer Near a Fallowed, Open-Net Fish Farm**", *Marine Pollution Bulletin*, Volume 64, Issue 9, September 2012, pp. 1970-1973; Inka Milewski, ***Nova Scotia Environmental Monitoring Program for Finfish Aquaculture: An Update (2006-2011)***, Atlantic Coalition for Aquaculture Reform, February 2013; and Inka Milewski, ***Aquaculture Survey and Macro-Invertebrate Analysis Report (Shelburne Harbour, Former Sandy Point Lease)***, Conservation Council of New Brunswick, February 2014.

in the literature include changes in planktonic communities around finfish aquaculture sites and eutrophication. The Committee agrees that further study is required and the knowledge gained will assist in decision-making regarding the monitoring and/or mitigation of far-field impacts associated with aquaculture operations; such knowledge could also lead to the development of new siting criteria and new monitoring tools. Moreover, such a study would contribute to the sustainable development of the industry.

4.2 Impact of Pest Control Product Use on Non-Target Organisms

Products used to control sea lice infestations are released into the surrounding environment after tarped cage or well-boat treatments, raising concerns about their potential impact on other organisms and the ecosystem. The Committee heard testimony on the findings of recent research investigating the use of these products and their potential impact on non-target organisms, more particularly on lobster.

Research conducted at the Marine Institute of Memorial University of Newfoundland examined how rapidly sea lice control products diluted and dispersed following treatment within tarp cages and well-boats, using different flow regime simulations representing various grow-out conditions on the East Coast. The research also investigated the implications of the release of pest control product on non-target organisms. The results showed rapid dilution/dispersion of the

The Fisheries and Marine Institute of Memorial University of Newfoundland is a world-class comprehensive centre for education, training, applied research, and industrial support for the ocean industries. Its School of Fisheries houses the Centre for Aquaculture and Seafood Development, which offers a complete range of services to the aquaculture industry in the areas of applied research, product and process development, technology transfer, advisory services, and training. The Committee met with university representatives and, while there, Senators were able to tour certain facilities.

products in the top layers of the water column. It was concluded that pest control products used for sea lice management are not expected to reach non-target organisms on the seabed under normal treatment operating conditions.[21]

Three more recent studies examined the dilution, dispersal and toxicity levels of the following three sea lice control products: Salmosan®, Paramove® 50 and AlphaMax®. It was shown that AlphaMax® did not dilute rapidly and did not reach a non-toxic level until close to a kilometer from individual treatment sites. In addition, AlphaMax® was shown to be highly toxic to crustaceans, including lobster. As a result, AlphaMax® is no longer approved for use in Canada. The studies also showed that Paramove® dissolved more quickly and at a shorter distance from site of release than the two other products; it was also found the least toxic of the three formulations. Its active ingredient is hydrogen peroxide, which degrades to oxygen and water and does not persist or bio-accumulate. With respect to Salmosan®, the studies showed that the product takes more time to disperse than Paramove® but reaches non-toxic levels within meters of treatment sites. It was shown that the potential impact of Salmosan® on non-target organisms, such as lobsters, depended on whether they are present within the zone of influence at the time of the treatment, as well as on their life stage. Finally, the studies showed that treatments administered in a well-boat reduced the toxic potential of these pest control products by at least three times.[22]

The Committee was pleased to learn that the findings of research informed the PMRA and led to the banned use of AlphaMax®. We also believe that the development and use of non-chemical approaches to sea lice control should lessen the industry's need to resort to these treatments. That said, we consider that research on the potential impact of sea lice treatments on non-target organisms, such as the ones we just summarized, should continue, since a wider range of products may be made available as part of the MUMS Program for Aquaculture that we recommended in the previous chapter. We further believe that this research should be performed by scientists from DFO, the PMRA, and Health Canada, with data generated from the reporting requirements under the proposed AAR.

With respect to concerns over increasing resistance to treatments used for sea lice control[23], the Committee believes that the industry should continue to carry out R-D into other emerging non-chemical methods of lice control such as treatment by freshwater, laser, cleaner-fish or by changing cage depth and design.

Overall, the Committee believes that the far-field impacts of aquaculture and the impact of pest control products on non-target organisms should

21 See: ***Construction and Evaluation of a Scale Model of a Finfish Cage under Different Flow Regimes Simulating Bath Therapeutant Exposure***.

22 F. H. Page and Les Burridge, ***Estimates of the Effects of Sea Lice Chemical Therapeutants on Non-Target Organisms Associated with Releases of Therapeutants from Tarped Net-Pens and Well-Boat Bath Treatments: A Discussion Paper***, Canadian Science Advisory Secretariat, DFO, December 2014; William Ernst et al., "**Dispersion and Toxicity to Non-Target Crustaceans of Azamethiphos and Deltamethrin after Sea Lice Treatments on Salmon Farms**," *Aquaculture*, Vol. 424-425, March 2014, pp. 104-112; and, Les Burridge, ***A Review of Potential Environmental Risks Associated with the Use of Pesticides to Treat Atlantic Salmon Against Infestations of Sea Lice in Southwest New Brunswick, Canada***, Canadian Science Advisory Secretariat, DFO, August 2013

23 Sonja Saksida *et al.*, ***Population Ecology and Epidemiology of Sea Lice in Canadian Waters***, Research Document 2015/004, Canadian Science Advisory Secretariat, DFO, March 2015.

be given priority in research. Accordingly, we recommend:

6. **That Fisheries and Oceans Canada undertake collaborative research on the far-field effects of marine finfish aquaculture and on the potential impacts of pest control products used for sea lice management on non-target organisms; these fields of research should be given priority.**

4.3 Impact on Wild Salmon Stocks

> *I have asked for you to hear my words that I speak from my heart for our people. I have asked you to hear these words in the context of something that is so spiritual to our people, it is wild salmon. The foundation of our culture and our traditions largely is based on feasting, and we turn to the resources in our territories in order to be able to sustain and perpetuate our culture that has been handed down to us through the eons. We take a very clear view on the importance of wild salmon over top of any other economic opportunity because this staple food is something that has become so integral to our people that we have bestowed upon it a very sacred dance.*
> *Chief Bob Chamberlin, Vice-President, Union of B.C. Indian Chiefs (4:148–149)*

4.3.1 Escapes

Aquaculture grow-out sites typically hold large numbers of fish. Damage to containment nets as a result of storms, boat collisions, and predator attacks in addition to possible inadequate net maintenance, mishandling of fish, vandalism, and other such events may lead to the escape of aquacultured fish into the surrounding environment, and if not caught in a timely fashion, beyond.

Grow-out infrastructure is highly regulated and inspected regularly. In addition, escape events must be reported by the aquaculture operator within a short delay to ensure that they are documented and that recapture efforts are sufficient to meet regulations. The Committee heard from DFO that escapes have declined in both frequency and number over the years in Canada as a result of: improved technology, enhanced maintenance of nets, better anchoring, stricter guidelines for vessels operating near aquaculture sites, improved codes of conduct and staff training for handling fish, and mandatory escape reporting and recapture plans.

The Committee, however, understands that despite these best efforts, escape events will always occur due to severe weather and human error, and also recognizes that the number of escapes cannot always be fully known. Therefore, the Committee believes that it is important to understand the negative impacts escapes have on the environment – more specifically on wild fish stocks – something that researchers have been working to gain knowledge about in Canada and abroad for several years now.

It is important to begin by noting that Atlantic salmon is grown on both Canada's East and West Coasts; even though Atlantic salmon is not native to the Pacific Ocean, it is a very important part of the aquaculture industry there. Escapes of this non-native fish species have been studied in B.C. and, during site visits in that province, the Committee learned that Atlantic salmon had not yet established itself in B.C. waters, although it has been grown there for about 30 years. Research suggests that the risk to wild Pacific salmon stocks from escaped aquacultured Atlantic salmon is low; there is minimal interaction between the aquacultured Atlantic salmon and the wild Pacific salmon, either through competition for habitat and food or as predators. In addition, escaped aquacultured

Atlantic salmon has not been shown to successfully mate with wild Pacific salmon, although they can successfully mate with wild fish of their own breed (which they have on the East Coast). The negative environmental impact of escaped aquacultured Atlantic salmon on the West Coast therefore appears to be low for the time being. However, the same cannot be said for the East Coast.

The Committee heard multiple witnesses who noted that one of the greatest concerns regarding Atlantic salmon escapes in the Atlantic Ocean is the potential for interbreeding or introgression with wild Atlantic salmon populations, which could cause genetic changes and reduce the fitness for survival of wild salmon in the area. In addition, certain wild salmon stocks on the East Coast have been assigned endangered or threatened[24] status by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and are therefore more at risk of weakening their gene pool should they mate with escaped aquacultured Atlantic salmon.

Studies conducted in both Canada[25] and Norway[26] (another country that, like Canada, has wild Atlantic salmon populations as well as an intensive Atlantic salmon aquaculture sector) showed interbreeding between wild and aquacultured populations and that this had reduced the next generation's ability to survive in the wild. However, the Norwegian study concluded that larger (and therefore healthier) wild populations were more resilient and therefore less affected (if not at all) by the escapes of aquacultured salmon. Conversely, weaker wild populations (such as those endangered or threatened) were more affected by the escaped salmon and showed more signs of genetic change due to interbreeding.

Although the Committee is encouraging the sustainable growth of the aquaculture industry in Canada, we believe that such growth should not be supported to the detriment of wild salmon stocks. Generally speaking, areas that are often ideal for salmon aquaculture operations are also those that are inhabited by wild salmon stocks. Restrictions should therefore be considered to ensure that aquaculture operations growing Atlantic salmon are located far from wild salmon populations that are deemed to be at risk. Reducing the number of escapes is an important step, but recognizing that escapes will inevitably occur, it is equally (if not more) important to adopt measures to reduce the negative impacts of escapes on wild salmon stocks whenever possible. In N.L., the Committee was told that the provincial government intends to work with DFO in the identification of areas that would remain aquaculture-free for these very reasons.

Norway has designated 52 National Salmon Rivers and 29 National Salmon Fjords and, within these areas, the salmon aquaculture industry is subject to stricter legislation (including a moratorium on aquaculture expansion in some regions and a ban on aquaculture operations in others). Scotland has also limited further finfish aquaculture growth on its north and east coasts to safeguard wild migratory species. For its part, Canada has 34 Atlantic Salmon

24 An *endangered* status refers to a wildlife species facing imminent extirpation or extinction, while a *threatened* status means a wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.

25 Vincent Bourret *et al.*, "**Temporal Change in Genetic Integrity Suggests Loss of Local Adaptation in a Wild Atlantic Salmon (Salmo Salar) Population Following Introgression by Farmed Escapees**", *Heredity*, No. 106, 2011, pp. 500-510.

26 Glover *et al.*, "**Atlantic Salmon Populations Invaded by Farmed Escapees: Quantifying Genetic Introgression With a Bayesian Approach and SNPs**", *BMC Genetics*, 2013.

Management Areas (SMAs), and salmon aquaculture occurs only in six SMAs.

A second measure introduced in Norway is the creation of the Escape Commission for Aquaculture, which is a permanent body that investigates all escape incidents, analyzes the causes of the events, and proposes regulatory improvements. Failure to report suspected escapes is a criminal offence. Norway is also contemplating the mandatory tagging of aquacultured salmon, the use of sterile fish, and the creation of a fund financed by the industry, to cover the cost of removing escaped fish from a representative number of rivers.

In an effort to better understand the health of wild salmon populations on the East Coast, DFO struck the Ministerial Advisory Committee on Atlantic Salmon in March 2015; its mandate is fourfold: 1) conservation and enforcement measures, 2) predation, 3) a strategy to address international, unsustainable fishing, and 4) focused areas for advancing science.[27] DFO is therefore committed to gaining more knowledge about wild Atlantic salmon stocks and this information could help DFO and the aquaculture industry re-evaluate, if necessary, the location and functioning of aquaculture operations growing Atlantic salmon, as well as help determine the risk associated with any new proposed aquaculture sites. This work could ultimately lead DFO to designate areas that would prohibit salmon aquaculture production, particularly where wild salmon populations are endangered or threatened.

In the past, DFO has given advice against proposed salmon aquaculture developments in areas where the status of wild salmon populations is of special concern. DFO must continue to provide such advice and this advice should always be accepted.[28]

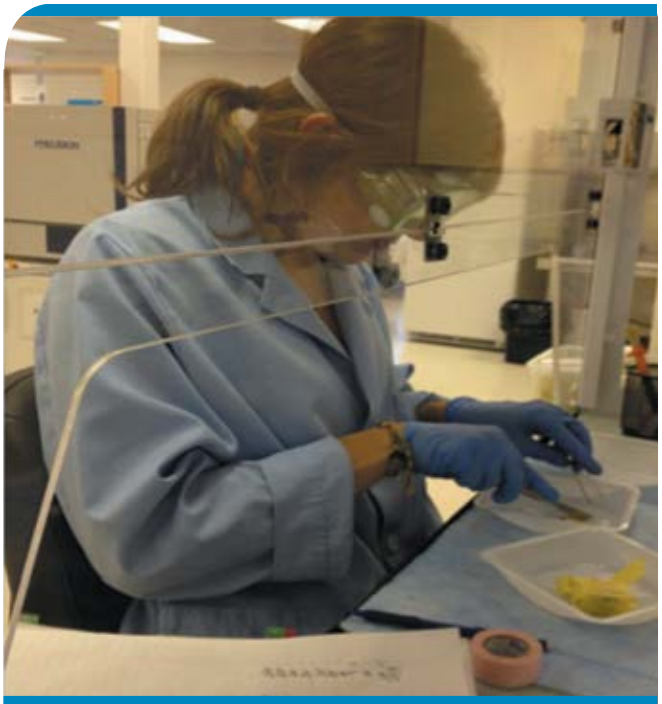
4.3.2 Pathogens in Aquaculture Operations and Out-migrating Juvenile Salmon

When fish are transferred into grow-out sites in the ocean, they come from a freshwater hatchery and, accordingly, are sea lice-free when they first enter the marine environment; they acquire sea lice from wild fish. The Committee was told that the high density of fish in a grow-out site amplifies the number of sea lice and increases the possibility of re-transmission back to wild fish. While the role of aquaculture grow-out sites, particularly those for Atlantic salmon, as potential reservoirs of sea lice is accepted, the effect of sea lice infestations on wild salmon populations is still debated. During the hearings in Nanaimo (B.C.), several witnesses expressed concerns about wild juvenile salmon swimming near aquaculture grow-out sites during their outmigration. They explained that, at that stage, the fish are very small and they do not have a scale load and are thus more susceptible to parasites like sea lice. The Committee was told that when juvenile salmon have one or two sea lice attached to them, they either die or become crippled and subject to predation or other pathogens.

In contrast, a study presented to the Committee showed that sea lice on aquacultured fish did not play a significant role in the decrease in wild Pacific (pink) salmon productivity. It noted that water temperatures, salinity and the abundance of food may be more important factors than sea lice. The study, which covered a 10-year period and used

27 DFO, "**Minister Shea Launches the Ministerial Advisory Committee on Atlantic Salmon**," *News Releases*, 9 March 2015.
28 See for example: DFO, ***Wild Salmon Populations in the Vicinity of a Proposed Finfish Aquaculture Development in St. Mary's Bay, Nova Scotia***, Canadian Scientific. Advisory Secretariat, Report 2011/001, May 2011.

data from the Broughton Archipelago region, concluded that separating aquacultured salmon from wild salmon – proposed through coordinated fallowing of juvenile salmon migration corridors or closed containment – would not increase wild salmon productivity.[29]



The BC Centre for Aquatic Health Sciences (BC CAHS) is a not-for-profit facility that undertakes research and provides services in the field of fish health for both wild and aquacultured marine species. Located in Campbell River, the BC CAHS is involved in fundamental and applied research projects with partners such as First Nations, industry, government, and academia. In operation since 2005, BC CAHS employs 11 people and is internationally renowned for its sea lice research, studying their effects on both wild and aquacultured fish populations. The Committee had the opportunity to tour the BC CAHS and meet with its researchers.

Photo courtesy of: BC Centre for Aquatic Health Sciences.

Nonetheless, the aquaculture companies operating in the Broughton Archipelago told the Committee that they are taking a precautionary approach to minimize the risk to wild juvenile salmon as they annually migrate to the open ocean in the spring.[30] For example, they may initiate winter treatment (anti-lice medication) of their fish, prior to the out-migration of wild juvenile salmon. They may also use non-medicinal methods, such as fallowing and reducing stocking densities. Furthermore, they indicated that they continue to research potential risks and new pest management techniques. They made reference to research by Peacock et al. which suggests that these measures have had positive outcomes for wild salmon populations.[31]

Similarly, witnesses spoke about the potential for transfer of disease between aquacultured and wild fish. According to some witnesses, this risk is low. The Committee was told that less than 1% of aquacultured salmon in B.C. die of diseases that might be infectious to wild Pacific salmon. Among the other 99%, 90% survive and 9% die of other causes. It was explained that the potential for infectious disease to spread from sick aquacultured salmon to other aquacultured salmon is greater than the potential for disease to spread from sick aquacultured salmon to wild salmon. Accordingly, witnesses suggested that it is reasonable to estimate that diseases from aquaculture sources

29 Gary D. Marty, Sonja M. Saksida, and Terrance J. Quinn, "**Relationship of Farm Salmon, Sea Lice and Wild Salmon Populations**," *Proceedings of the National Academy of Sciences*, 13 December 2010.

30 The most recent peer-reviewed scientific advice prepared by DFO on this topic suggests that the risk of sea lice transmission from aquaculture grow-out sites to wild juvenile salmonids is likely highest during the out-migration period. See: DFO, ***Sea Lice Monitoring and Non-Chemical Measures***, Canadian Science Advisory Secretariat, July 2014.

31 Stephanie J. Peacock, Martin Krkosek, Stan Proboszcz, Craig Orr, and Mark A. Lewis, "**Cessation of a Salmon Decline with Control of Parasites**," *Ecological Applications*, Vol. 23, No. 3, April 2013, pp. 606–620.

kill less than 1% of wild salmon per year. This rate, it was stressed, is much lower than the estimated natural mortality of juvenile wild salmon of 3% per day.

While these data are encouraging to the Committee, it must be recognized that there is a lack of knowledge about the health of wild Pacific salmon stocks. We were pleased to learn that the high mortality rate of wild juvenile salmon during their early ocean migration is the focus of a six-year (2012-2018) collaborative study by DFO, the Pacific Salmon Foundation and Genome BC. Called the Strategic Salmon Health Initiative, the study intends to clarify the presence and/or absence of 45 pathogens in samples collected in wild, hatchery and aquacultured salmonids in B.C.[32] For this study, a novel technology, the Fluidigm BioMark™ HD System, will be used and the samples will undergo histopathological analysis and gene expression profiling to identify pathogens most likely associated with disease. It is the view of the Committee that this research will inform improved risk assessment related to pathogen transfer from aquacultured to wild salmon, as well as the current moratorium on aquaculture development in the Discovery Islands area.

4.4 Impact of Shellfish Aquaculture

The Committee had the opportunity to visit several shellfish aquaculture operations (one hatchery-nursery, two grow-out sites, one depuration plant, and three processing plants) and held panel discussions specifically devoted to shellfish aquaculture in each city where public hearings took place. Overall, we heard less testimony on the environmental impacts of shellfish aquaculture, in comparison with marine finfish aquaculture.

However, witnesses who spoke about specific environmental concerns regarding this aquaculture sector raised important issues.

For example, certain shellfish aquaculture operations in B.C. have been known to generate large amounts of debris, such as plastic and Styrofoam®, which are left in waters and on shores. In addition, when production comes to a close at certain locations, gear and other apparatus are abandoned in the water instead of being removed. Although these operations only represent a limited number of shellfish growers across Canada, they hinder the reputation and social licence of other shellfish growers that are vigilant in their use of the environment and considerate of other users. The Committee cannot in good conscience condone operations working in this manner.

Whether the code of practice in place was not followed by the operators – which should have been evident to industry – or there was a lack of enforcement by DFO inspectors who are responsible for their oversight, situations such as these are unacceptable and action should be taken to stop this misuse of public waters. Regardless of the reasons why, shellfish growers who operate in this fashion should see their licences revoked. In addition, to avoid situations where equipment is left in public waters once the operation has closed, licence conditions should require operators to decommission their grow-out sites and conduct any remediation required, including shoreline remediation when required, at their own cost.

That being said, DFO is responsible for licensing shellfish aquaculture in B.C. and for ensuring compliance with the licence conditions and the provisions under the *Pacific Aquaculture Regulations*. Furthermore, the Committee believes that site

32 Genome British Columbia, ***Strategic Salmon Health Initiative***.

debris should be managed appropriately in all aquaculture sectors – shellfish and finfish – and in all regions – both the West and the East Coasts. Accordingly, we recommend:

7. **That Fisheries and Oceans Canada regularly undertake inspections and consistently enforce compliance in relation to shellfish aquaculture in British Columbia and, in particular, in situations where any floating material or other debris (such as shells, ropes, and buoys) is not disposed of as prescribed and/or remains in the marine environment; the Department should equally act in situations where aquaculture operators in other provinces leave debris in the marine environment.**

In contrast to the unfortunate examples above, the shellfish aquaculture sector in the other provinces has developed and enforced codes of conduct to complement the various regulatory mechanisms in place; these codes define practical steps to achieve greater environmental stewardship within the shellfish aquaculture sector. The B.C. shellfish aquaculture sector also has its own code of practice and the Committee strongly encourages the industry to strictly enforce it.

More common environmental concerns related to shellfish aquaculture are those related to organic matter deposition. Aquacultured shellfish are not fed in the same fashion as aquacultured finfish since they are filter feeders, which means that they feed on particulates suspended in the water column; there is therefore no wasted feed that accumulates in the benthic environment.

The Committee visited the Centre for Shellfish Research, which forms part of the Deep Bay Marine Field Station. Operated by Vancouver Island University, the Centre undertakes research activities aimed at sustainable shellfish aquaculture development, preservation of coastal ecosystems, and more.

Photo courtesy of: Deep Bay Marine Field Station.

However, fecal matter deposition does occur and does contribute to some organic matter accumulation. The Committee did not receive testimony regarding longer-term benthic impacts.

4.5 Impact of Freshwater Aquaculture

> *We [the freshwater aquaculture industry] will monitor the way we are, and we'll use the principle of adaptive management. If we grow and we find that we are having an impact … then we'll use adaptive management, which is a precautionary principle to us. We'll figure out what's going on and do what we have to do to mitigate whatever the effect is that's perceived to be or is a negative. Mike Meeker, President, Northern Ontario Aquaculture Association (17:22)*

In contrast to marine aquaculture, the Committee heard from very few witnesses who specifically discussed freshwater aquaculture. Our fact-finding missions led us to visit regions of the country where the marine aquaculture sector operates, the sector that generates most of the aquaculture production in Canada. What we learned during the hearings is that freshwater aquaculture challenges seem to differ to some extent from those faced by marine-based aquaculture. Since Canada has vast untapped freshwater aquaculture potential, it appeared to us that the continuation and expansion of research and knowledge specific to freshwater environments is crucial if this segment of the industry is to grow sustainably alongside marine-based aquaculture.

We learned that, like in marine-based aquaculture, freshwater aquaculture operators must monitor the health of their stock to help prevent disease outbreaks. Similarly, pathogens are naturally-occurring in freshwater environments as they are in marine environments. However, the Committee heard that with good management practices and vigilance about the health of stocks, disease management appears to be less of a concern in freshwater environments than it is in marine environments. In fact, the ON rainbow trout grower who appeared before the Committee has not used any drugs or pest control products in his production over the past eight years and has become the country's first producer of certified organic rainbow trout according to the Canadian standard.

The greatest concern associated with freshwater aquaculture seems to be nutrient loading – more specifically, phosphorus loading due to the environment's limited flushing capacity. For this reason, certain witnesses called for the use of closed-containment systems instead of the net cages that are presently in place in the freshwater aquaculture sector in ON. On the other hand, the Committee also heard of freshwater aquaculture operations that have coexisted at Manitoulin Island for several decades with limited negative environmental impacts.

During the hearings, we learned about research undertaken since 2001 at the Experimental Lakes Area (ELA). Considered the world's biggest natural wet lab, the ELA is operated by DFO and holds 58 small lakes in a forested region of northwest ON. A 12-tonne aquaculture cage is stocked every spring in Lake 375 with 10,000 rainbow trout (this corresponds to a higher density than a usual operation); fish are fed twice daily and harvested around the end of October. Operations take place as at a normal grow-out site, except for scientists measuring everything possible. Another adjacent reference lake is used for comparisons. What has been learned so far? We were told that some sediment builds up under the cage during normal operations, and some organisms normally present on the bottom abandon the area. Sediments taken at different intervals away from the cage show little change from background measurements.

Moreover, the wild lake trout population grows faster and reproduces more rapidly in Lake 375 than those in the reference lake.

The Committee also heard about an interesting experiment in Sudbury, ON, where fish are grown for stocking purposes at 5,000 feet underground in an abandoned mine shaft. The ambient temperature of the water in the shaft is constant, at about 22 degrees Celsius year-round and appears to be an incredible resource of free heat for use. We also heard about another innovative technology developed for use in freshwater aquaculture, the submersible cage. A commercial net cage was modified so that it can be lowered and allows ice to move over the cage during the spring season and eliminates the risk of wind-driven ice movements that may damage fish cages and cause economic and environmental losses for aquaculture operators.

The Committee was told that rainbow trout is the species generally grown in ON's freshwater aquaculture sector, but we also heard that there is great potential to branch out into other types of finfish species. If this can occur in a sustainable manner, the Committee is in favour of the development of this segment of the industry, understanding that its challenges and regulatory framework differ somewhat from those of the marine finfish sector.

Under the proposed AAR, DFO will regulate on a pan-Canadian basis the use of drugs and pest control products in marine aquaculture operations, as well as the deposition of organic matter. The Committee believes that DFO should consider the establishment of regulations similar to the AAR for application to freshwater aquaculture across the country. We further believe that, as freshwater cage aquaculture grows, it will be important to continue to monitor its effects on Canada's lakes.

CHAPTER 5: Research and Development

> *If I could leave you with one recommendation, we need our federal government to maintain and even increase funding for science, research and development. It is so fundamental to the success and the future of Canada's aquaculture sector. Michael Szemerda, VP, Saltwater Operations, Cooke Aquaculture (14:153)*

There is a strong foundation of aquaculture research in Canada. At the federal level, several departments and agencies fund, carry out and/or collaborate on aquaculture-related research. During site visits throughout Canada, the Committee visited several research facilities that have been performing world-class R-D on a wide range of topics related to aquaculture for decades. This research has helped improve the industry's environmental performance and led to stricter government regulations. During our fact-finding missions to Norway and Scotland, we were told that Canada is internationally recognized for the high calibre of its aquaculture R-D and that the effectiveness of its research could be further improved through stronger collaboration. The Committee believes that improved coordination of R-D activities coupled with effective collaboration between those that support aquaculture-related R-D will be imperative to ensuring that the aquaculture industry continues to thrive.

Furthermore, the Committee believes that it is important for R-D to continue to inform the aquaculture regulatory framework and the environmental performance of the industry. Siting criteria, aquaculture-related regulations, monitoring practices, reporting requirements, and more should regularly be revised and updated in light of new R-D findings and proven best practices. In our view, such a revision cycle is of paramount importance if the Canadian aquaculture industry wants to remain competitive in the global market and continue to foster its social licence.

5.1 Federal Aquaculture Research

DFO administers two research programs devoted to aquaculture. Under the Program for Aquaculture Regulatory Research (PARR), research focuses on: aquacultured-wild fish interactions, the cumulative effects of aquaculture on the environment, far-field effects and ecosystem interactions. Research under the PARR is funded and undertaken by DFO, and mainly serves to support industry management, management decisions, and the development of policies and regulations. For its part, the Aquaculture Collaborative Research and Development Program (ACRDP) supports research in relation to fish health optimization and the industry's environmental performance.[33] The ACRDP is a collaborative program, whereby industry provides some of the funding, but the work is undertaken by DFO researchers.

In addition to DFO, the Committee heard about a number of other federal departments and agencies funding aquaculture research. For example, the Natural Sciences and Engineering Research Council (NSERC) provides funds to universities and the academic community in Canada. Some of its programs provide research funds to university researchers who undertake aquaculture-related studies. Other NSERC programs encourage collaboration between industry and academic researchers, as well as the development of research networks. Similarly, the National Research Council of Canada (NRC) administers the Industrial Research Assistance Program (IRAP), which provides funds for innovative, technical industrial projects. In

33 DFO, ***Canada's Sustainable Aquaculture Program – Increasing our Scientific Knowledge***, Backgrounder, 14 February 2014.

addition, regional development agencies, such as the Atlantic Canada Opportunities Agency (ACOA), fund developmental projects in various regions.

Industry representatives told the Committee that, while they understood the importance of regulatory research and DFO's focus on regulatory science, they felt that more federal funding should be available for research into operational aspects of aquaculture that would be useful to the whole of the industry. For the finfish aquaculture sector, this could include research into stock development, fish development, vaccine development, and fish health, as well as genomic research in the areas of elite broodstock development, feed optimization, and effective disease and pest management strategies. In the area of shellfish aquaculture, we were told that research into AIS should be prioritized, as well as into the potential impact of ocean acidification on shellfish aquaculture. Furthermore, we were reminded that many segments of the aquaculture industry consist almost entirely of small and medium size enterprises (SMEs), including several shellfish growers and most RAS facilities supplying niche markets, and the freshwater sector. These SMEs have a very limited research capacity, and it is important to invest in the type of research that can help these companies become or remain competitive globally, including: research on production efficiencies; processing efficiencies and automation; fish health; integrated pest management; environmental impacts of aquaculture; broodstock genetics; and by-product utilization.

Several witnesses noted that the federal government had reduced investments in aquaculture research programs in recent years. Furthermore, it was stressed that budget cutbacks at the federal and provincial levels make it difficult for industry, particularly for SMEs, to leverage funding and expertise for collaborative research.

The Committee believes that PARR provides critical insight to further improve the regulatory regime under which Canadian aquaculture is managed. The current emphasis of the program on aquacultured-wild fish interactions, the cumulative effects of aquaculture, and far-field impacts is in line with the priority areas of research noted during our study. Similarly, we believe that the ACRDP has great potential as it encourages industry and DFO researchers to undertake collaborative research activities with the goal of improving the competitiveness of the Canadian aquaculture industry. The R-D activities carried out under the two programs are important. Given limited resources, it is imperative to prioritize research to improve environmental management and environmental performance in aquaculture. In the context of limited financial resources, priority funding should be given to collaborative work.

5.2 Collaborative Research

> *When I think about how to increase aquaculture [in Canada], it's clear to me that the direction of this industry must be science-based in partnership with industry and ecosystem managers. It's less costly to ensure that investments into science are put at the front end of the development of the industry than to have problems develop and require science to find mitigation solutions after the fact. Sarah Stewart-Clark, Assistant Professor, Shellfish Aquaculture, Faculty of Aquaculture, Dalhousie University (10:70–71)*

A message consistently heard by the Committee during site visits in Canada and abroad relates to the need to foster aquaculture research collaboration between scientists and researchers from government departments, academia and industry.

We learned that in Norway, there is a tradition of strong collaboration between industry, regulatory authorities and academia in aquaculture research. The Committee was told that cooperation and exchange of information between government, academic researchers and the industry contribute to making Norwegian aquaculture innovative and cutting-edge. The results of this collaborative research are used to reform the regulatory regime and make improvements in production practices. Scotland, like Norway, aims to foster collaboration between universities, businesses and other stakeholders in aquaculture research and recently established the Scottish Aquaculture Innovation Centre. The Centre brings together industry and academia to provide innovative solutions with the aim of setting winning conditions for the industry to grow economically and sustainably.

In N.L., as part of the provincial aquaculture strategy launched in 2014, an advisory committee has been established to review current research activities in the province and to provide recommendations to strengthen collaboration among that research community. Stronger collaboration in the field of research is seen as a prerequisite to a growing aquaculture industry in the province.

The Committee also learned that, between 1999 and 2006, the federal government financially supported AquaNet, a network of centres of excellence whose goal was to foster the sustainable

While in St. John's, the Committee visited the Ocean Sciences Centre (OSC) of Memorial University, which is a world-class marine research and training facility that provides oceanfront training on a year-round basis and embodies one of Canada's largest marine laboratories. The Committee had the opportunity to visit two of the OSC's facilities: the Dr. Joe Brown Aquatic Research Building, which supports research, training, pre commercial production, and small scale commercial trials in marine aquaculture; and the Cold-Ocean Deep-Sea Research Facility, which provides several multi-tank systems and equipment for the study of deep-sea life, aquatic infectious diseases, and invasive organisms.

Photo courtesy of: Ocean Sciences Centre, Memorial University.

development of aquaculture in Canada through collaborative research. To facilitate the growth of a sustainable aquaculture industry in the next ten years in Canada, the Committee believes that a formal mechanism fostering research collaboration between federal and provincial departments, all segments of the industry and academia should be developed. Therefore, the Committee recommends:

8. **That Fisheries and Oceans Canada develop without delay a formal mechanism with the provinces, the research community and the industry to foster collaborative research and development in the field of aquaculture.**

5.3 Synthesizing Research and Communicating its Findings

On more than one occasion during the hearings, witnesses pointed to the need for synthesizing the results of current research. They explained that, while a considerable amount of research has been conducted on the potential effects of aquaculture on the environment in Canada and abroad, this body of research has never been compiled, synthesized, and interpreted to provide a "big picture" view of the industry in terms the general public can understand. The research carried out by a wide range of experts and groups, research foundations, DFO scientists, Canadian universities, and international experts is disjointed and needs to be brought together. This exercise, albeit a large undertaking, could: 1) help inform Canadians about research already conducted and its main findings; 2) highlight the research currently underway to identify R-D gaps or areas for which there are no conclusive findings, that are causes of particular concern or simply require further study; and 3) continue to make Canada a leader in aquaculture research.

Moreover, the results of this exercise should be communicated to the general public in a way they can easily assimilate. It is the view of the Committee that this information will contribute to more informed discussions and debates on aquaculture, and help everyone understand how the industry can continue to operate and grow sustainably into the future. Therefore, the Committee recommends:

9. **That Fisheries and Oceans Canada complete within the next two years a thorough assessment of aquaculture research to inform the public on the main findings and identify gaps in research and development that would become the focus of future research.**

CHAPTER 6: Social Licence and Public Reporting

> *"One of the reasons we think that people are unsure about our industry is because salmon farming is ever changing… There is a natural inclination to fear what we don't understand (…)." Pamela Parker, Executive Director, Atlantic Canada Fish Farmers Association (10:9-10)*

The Canadian aquaculture industry annually generates $1 billion worth of positive benefits, including direct and indirect employment and the production of healthy and nutritious proteins. Nonetheless, public concern about its environmental effects remains high in some parts of the country, reducing its social licence.

As we have noted in the previous chapters, some of these concerns are genuine and stem from irresponsible practices and/or inadequate management. Correcting these situations will certainly help improve the aquaculture industry's social acceptance. For industry, this means being socially responsible and capable of demonstrating its sustainability – economically, socially and environmentally.

Government can help improve aquaculture's social licence by adopting and enforcing a rigorous and science-based governance framework that protects precious resources – our wild salmon stocks, other wild fish populations, and sensitive habitats – and preserves them for years to come. Public trust can also be improved by government openly providing information about the aquaculture industry and disclosing the industry's environmental performance data.

It is difficult, however, for the industry to gain and maintain public confidence when misinformation circulates about aquaculture. As a first step, such misinformation must be addressed.

6.1 Correcting Misinformation

What struck us during our study was the amount of contradicting testimony in relation to the environmental impacts of aquaculture, where some witnesses were stating one thing with certainty, while others would state the complete opposite... with certainty! On more than one occasion, we found ourselves discussing this issue and the possibility that misinformation was being presented – although the Committee does not believe that it was done intentionally.

We believe that contradicting testimony was often the result of the generalization of certain facts rather than sound conclusions pulled from scientific research. In our view, misinformation, generalization, and misinterpretation should be avoided at all costs. Through the experience gained over this 18-month study, the Committee would like to clarify certain matters that, at first sight, seemed very contentious, but with time and information, were found to be the perpetuation of perceptions and misinformation. It is our hope that these explanations will provide clarity on certain contentious topics and consequently improve the debate on aquaculture in Canada.

6.1.1 Benthic Environment

One such perception is that waste from finfish aquaculture operations simply accumulates in lake and ocean bottom sediments over time and surpasses the environment's carrying capacity. In fact, as noted previously, aquaculture licence conditions require that once aquaculture finfish have been harvested, sites must remain fallow for a time to ensure the environment returns to its natural state prior to new stock being introduced. In addition, siting criteria ensure that potential aquaculture sites are biophysically suitable for this type of activity, while licence conditions require

regular sediment sample testing to monitor benthic health. New monitoring requirements for organic matter deposition to be implemented pursuant to DFO's proposed AAR for finfish operations will ensure that thresholds are respected by operators and enforced by inspectors.

The science presented to the Committee clearly demonstrated that in the long-term, when practised as per stipulated conditions and applicable legislation, aquaculture activities do not negatively impact the benthic environment and on the rare occasions when it does, monitoring is in place to minimize (or reverse) negative impacts. Unfortunately, certain benthic environments have not fully recovered from aquaculture activities (as discussed in Chapter 4), but these represent a minority of sites. In addition to these sites no longer being used for aquaculture, events such as these help update the regulatory framework to ensure it does not occur again. These few examples should not be generalized as they unfairly taint the industry as a whole.

In Gaspé, the Committee met with representatives from the Québec Fisheries and Aquaculture Innovation Centre (Merinov) to learn about its aquaculture activities. Established in 2010, Merinov is a not-for-profit organization that carries out projects involving research and development, technology transfer, technical assistance, and monitoring. Its goal is to "contribute to the sustainable development and competitiveness of Québec's aquaculture industry."

6.1.2 Infectious Salmon Anaemia

There is an ongoing debate about the presence of ISA on Canada's West Coast. DFO and the CFIA as well as other researchers are adamant that ISA is not present in B.C. waters. However, a few independent researchers continue to claim that the disease is present in B.C. waters and threatens wild fish populations. The Committee was made aware of one laboratory obtaining a positive ISA reading in the Pacific Ocean, but was told that at times, false-positive results can be obtained. In addition, the Committee was informed that the laboratory in question had been stripped of certain accreditations due to poor practices.

As we understand it, should an ISA outbreak occur, the virus could spread quickly if no mitigation measures are taken immediately. As a corollary, if ISA was in fact present in B.C. waters, it is likely that at least one ISA outbreak would have occurred and been reported to CFIA, which simply has not happened. Two explanations therefore lend themselves to the current situation: 1) ISA is not present in B.C. waters, or 2) if ISA is present in B.C. waters, the strain is one that does not cause disease. Either way, we do not believe that ISA is presently a concern in regards to the health of aquacultured or wild fish stocks in B.C. However, it remains a highly contentious topic that maims the reputation of salmon aquaculture operations in B.C.

6.1.3 Piscine Reovirus

During the Nanaimo hearings, a witness suggested that a new virus – the Piscine Reovirus (PRV) – had been introduced to B.C. waters by salmon aquaculture companies through smolt imported from Norway and that the virus was a causative agent of Heart and Skeletal Muscle Inflammation (HSMI). However, a recent study found that PRV is not a new virus in the Pacific Ocean and that it was first identified in 1977 in a wild-source steelhead trout from B.C.; thus, predating the start of salmon aquaculture in the province. The study also confirmed that the fish that carry PRV did not show any signs of disease, such as HSMI.[34] Unfortunately, the perpetuation of such misinformation causes harm to the aquaculture industry in B.C. and across Canada and feeds the fear that aquaculture will or has already introduced foreign pathogens into B.C. waters, which is simply not the case.

A recent Federal Court Decision, *Morton v. Canada (Fisheries and Oceans)*,[35] briefly discussed PRV as a possible viral precursor to HSMI. The decision did not rule on that point since it was not the matter in question, but it is important to note, however, that this became a focal point of interest when the ruling was covered by the media. The decision does, however, note that the causal relationship between PRV and HSMI had not been conclusively established.

6.1.4 Sea Lice Treatments

During the public hearings in N.S., the Committee often heard witnesses from that province express concerns about the use of sea lice control products; they noted that these products harm their local marine environments as well as non-target species. However, industry representatives informed the Committee that, over the last 10 years, there have not been any sea lice treatments in N.S. at salmon grow-out sites. They explained that sea lice levels in N.S. are below the levels at which treatment

34 Gary Marty et al., "**Piscine Reovirus in Wild and Farmed Salmonids in British Columbia, Canada: 1974–2013**," *Journal of Fish Diseases*, 22 July 2014.
35 Federal Court of Canada, **Decision 2015 FC 575**, 6 May 2015.

would be required. We were told that the low prevalence of sea lice is, at least in part, due to the relatively limited scale and wider distribution of the salmon aquaculture sector in the province. Although the Committee understands why witnesses from other provinces expressed concern about the environmental impact of the use of sea lice control products, why witnesses from N.S. discussed this issue is unclear. It is the view of the Committee that this is a good example of the generalization of a concern, which leads some to think that salmon aquaculture operations are regularly treating sea lice in N.S., which is not the case.

6.1.5 Aquaculture Activities Regulations

A number of witnesses raised objection to DFO's proposed AAR on several occasions during the Committee's study. In their opinion, the proposed regulations would allow industry to use deleterious substances such as veterinary drugs and pest control products more freely and more intensively. The goal of the AAR is precisely the opposite; it aims to regulate the use of deleterious substances more strictly through monitoring and reporting of each treatment and encourage recourse to non-chemical alternatives.

Provisions governing the use of veterinary drugs and pest control products such as those proposed in the AAR are necessary to correct an important incoherence in the current federal aquaculture regulatory framework. The aquaculture industry has used products considered to be "deleterious substances" pursuant to the *Fisheries Act* definition in its ongoing activities for several years. In doing so, aquaculture operators are in breach of the *Fisheries Act*, even though the products used are sanctioned by the *Food and Drugs Act* (FDA) and the *Pest Control Products Act* (PCPA), which places the industry as a whole in an awkward position. The proposed AAR will eliminate that incoherence, by setting out exceptions under sections 35 and 36 of the *Fisheries Act*, while still regulating the industry's use of the substances under the FDA and PCPA as is presently done.

Unfortunately, when the proposed AAR were discussed by some witnesses, the concern over the use of deleterious substances overtook discussions, which not only leads to misinformation, but also paints a grim picture of the regulations, which in fact, when implemented, will solidify the legislative framework governing aquaculture in Canada (not weaken it).

6.2 Involving Communities

> *Social licence needs to be earned and then maintained by companies at the community level and it is not likely or expected to ever represent a 100 per cent consensus. Murray Hill, Regional Manager, Atlantic Canada Fish Farmers Association (14:39)*

The Committee was told that the industry's most important tool to gain or enhance social licence vis-à-vis aquaculture is public consultation/ engagement very early in the siting and licence application process. This provides a forum where the industry can: explain how it operates; demonstrate the potential economic opportunities that can be realized within the community; and answer any questions, speak to any concerns and discuss any potential conflicts raised by residents. The sooner these issues are identified, the better they can be addressed. As noted in Chapter 1, First Nations know a great deal about the areas where they live and aquaculture companies could greatly benefit from their traditional knowledge in their search for suitable aquaculture sites.

Today, several First Nations throughout Canada are engaged in aquaculture development to generate employment and prosperity in their communities.

The Committee had the opportunity to meet with many of them or heard about their participation in aquaculture as part of our hearings and site visits, including: Ahousaht, Kitasoo, Kyuquot, Quatsino, and K'omoks in B.C.; Eel River Bar and Listuguj in N.B.; Miawpukek in N.L.; Potlotek and Waycobah in N.S.; and Mi'kmaq in P.E.I. In contrast, some other First Nations are more reluctant to become involved in aquaculture as they are uncertain about the environmental effects of aquaculture development. Still, the Committee heard from other First Nations who are opposed to aquaculture development within their traditional territories. Increasing awareness of the potential opportunities afforded by aquaculture and correcting misinformation regarding the environmental effects of the industry would certainly contribute to broader engagement in aquaculture by First Nations and other Aboriginal communities.

The Committee also heard that public engagement must be maintained once aquaculture operations are established. For example, some companies have a community liaison committee in each of the areas where they operate, with membership that includes business people, fishermen, harbour authority representatives, Aboriginal groups, community leaders and citizens – both those who support aquaculture as well as those who do not. An independent facilitator chairs the committee. This forum provides a place for dialogue where people can have open and honest conversations (not debates) about the industry in their community.

6.3 Reporting to the Public

The Committee heard that it is not the government's duty to grant social licence and that it should be done at the community level. Nevertheless, government can aid the aquaculture industry gain social licence by establishing a sound and science-based regulatory framework, such as the one we recommend in this report. Government can also contribute to social acceptance by publicly recognizing best practices and demonstrating industry legitimacy. Certain industry representatives suggested that certificates of compliance should be issued to aquaculture companies for display; these certificates would show other stakeholders and the public that companies are operating in a sustainable and responsible manner. Other members of the industry suggested that annual reports be published by government on compliance. Communicating the results of research as discussed in Chapter 5 and demystifying the regulatory framework surrounding the industry would go a long way to encouraging public acceptance of aquaculture, and increase confidence that aquaculture development is being managed in a manner that is congruent with the values of Canadian society.

In Norway and Scotland, reporting information to the public on a wide range of topics related to the aquaculture industry is a tool used to enhance social acceptance. As shown in Volume Two, information on disease and parasites affecting aquacultured and wild fish is routinely collected by the Norwegian Veterinary Institute and made available to the public on an annual basis. Data on the use of pharmaceuticals is also published annually by the Norwegian Institute of Public Health. Furthermore, data on aquaculture facility escapes are published regularly by the Department for Fisheries and Aquaculture.

Similarly, the Scottish Government makes aquaculture regulatory information accessible through a data search tool and an interactive map available on Scotland's Aquaculture website, launched in 2013. A wide range of data is provided, such as industry location, reports on controlled activities, monthly biomass measurements, escapes, sea lice in-feed treatment residues, and more. In addition, Marine Scotland's Fish Health

Inspectorate proactively publishes information on its inspections and operational activities on a quarterly basis. Moreover, the Scottish Salmon Producers Organisation voluntarily publishes quarterly information on sea lice levels per region.

In Canada, given federal and provincial responsibilities over aquaculture, there is no single agency reporting information about the industry to the public. The availability of data shared with the public and the extent of the information provided vary from one province to another. In general, there is a concern in Canada about a lack of reporting of information regarding the aquaculture industry, particularly on disease outbreaks, the use of chemicals, escape events and impacts on the benthic environment. It is also argued that, when information is made available, it is not released in a timely fashion. This concern is being addressed to some extent by DFO. Under the proposed AAR, aquaculture operators will be required to report, on an annual basis, the use of drugs or pest control products, the purpose of use, the date and quantity used, and a record of consideration of treatment alternatives, as well as the results of benthic monitoring, and more. This information will be reported annually to DFO and subsequently made public. This will be in addition to information that is already available on provincial regulatory authorities' websites, as well as on DFO's website in relation to B.C.

The Committee was pleased to learn that the information DFO will collect under the proposed AAR will be made available to Canadians to demonstrate how DFO is managing aquaculture, but more importantly, to demonstrate the industry's actual environmental performance across the country. However, these data will be aggregated, not presented for each operator. Furthermore, other information/data reported to the provinces will be found in separate locations. In order to ensure that Canadians seeking information on aquaculture operations can find it in a single convenient place, the Committee recommends:

10. **That Fisheries and Oceans Canada, with input from the provinces via the Canadian Council of Fisheries and Aquaculture Ministers, establish within the next two years a central database accessible to the public that contains all currently available information pertaining to the licence and compliance of each aquaculture operator.**

CONCLUSION

The Committee carefully reviewed the vast amount of evidence received and is confident that the Canadian aquaculture industry can continue to innovate and grow sustainably – environmentally, economically and socially. With untapped marine and freshwater resources, a diversified industry, innovative RAS entrepreneurs, world-class aquaculture research, a rigorous, science-based and streamlined regulatory framework, and transparent communication and information about the industry, Canada has the potential to become a major player in global aquaculture production.

We feel that there is a window of opportunity for implementing the recommendations proposed in Volume Three. The industry, rural, coastal and Aboriginal communities, research institutes, universities, government representatives, and more all called for a change to the regulatory framework in one way or another. There is also a momentum building, both within Canada (particularly in N.L. and N.S.) and abroad – particularly Norway and Scotland – to review and renew aquaculture-related legislation and policy to help encourage the sustainable growth of this industry. Let's not miss this opportunity, because aquaculture capital is mobile; companies willing to invest may look elsewhere to expand their operations, leaving Canada treading water, when it has an ocean of opportunities!

APPENDIX A: Glossary

Aquaculture	The cultivation and harvesting of aquatic organisms – finfish, shellfish, molluscs and aquatic plants – in the marine environment, freshwater environment (in lakes and ponds) or in tanks on land. Monoculture refers to the cultivation of a single crop or species, while polyculture or IMTA refers to the rearing of two or more complementary species in the same grow-out site.
Bay Management Area	Government, with industry's collaboration, delimits zones where aquaculture operations are synchronized. These zones prescribe best practices and strict biosecurity procedures. The use of BMAs is considered a sound and scientifically-based method of reducing pathogens.
Benthic environment or Benthos	Refers to the bottom under a body of water. The term "benthos" refers to organisms that inhabit the bottom environment.
Biomass	The total live weight of a stock of aquatic organisms in a growing area, at a particular time.
Biosecurity	Refers to the precautionary measures taken to minimize the risk of introduction and spread of potential pathogens in an aquaculture facility.
Broodstock	Population of mature animals selected for breeding; they will produce the next generation of cultivated fish.
Capacity (Assimilative or Carrying)	Assimilative or carrying capacity refers to the capacity of a particular body of water to support the growth of healthy aquatic animals over a long period without negative effects to an ecosystem's productivity, adaptability and capacity for renewal.
Chemotherapeutant	Means vaccines, veterinary drugs and pest control products used to combat disease and pests in aquatic organisms.
Cleaner-fish	Species of fish that can use their specialized mouthparts to detach lice and other parasites from fish.
Depuration	Technique whereby aquatic organisms, usually shellfish, are placed and held in clean water to clean themselves of undesirable substances (sand, pollutants, etc.) of possible harm to human beings.
Economic Impact	Include direct, indirect and induced impacts of an industry.
Eutrophication	Natural or artificial nutrient enrichment in a body of water, associated with extensive plankton blooms and subsequent reduction of dissolved oxygen.
Fallowing	A process where grow-out sites normally used for production are left to recover for a period of time.
Farm-gate value	The farm-gate value represents a product's value once it is sold by the producer.

Fouling organism or biofouling	Organisms that grow on submersed aquaculture equipment (such as algae) often to the detriment of the equipment and the health of the aquacultured organisms.
Genome	An organism's entire genetic make-up or complete DNA structure.
Grow-out site	Refers to the area in which the aquacultured finfish or shellfish will be grown to maturity.
Hatchery	Place for artificial breeding, hatching and rearing through the early life stages of aquatic organisms. Generally, in finfish aquaculture, hatcheries and nurseries are closely associated. On the contrary, in shellfish aquaculture, specific nurseries are common, where larvae produced in hatcheries are grown until ready for stocking grow-out sites.
Integration (Horizontal or Vertical) and Consolidation	Horizontal integration or consolidation refers to the process through which companies grow laterally by gaining control over other firms performing similar activities at the same level in the marketing sequence. Vertical integration refers to the process of bringing two or more successive stages of production and/or distribution of a product under the same control. For example, aquaculture hatcheries, grow-out operations, feed manufacturing, processing, and product marketing.
Level or Trophic Level	The position an organism occupies in the food web (e.g. primary producers, primary consumer, predators).
Net cage	Enclosure where aquaculture products are grown in marine and freshwater environments. Enclosures are closed on the bottom as well as on the sides, generally with mesh or net screens and allow natural water exchange. Often, enclosures are also fitted with a top mesh to reduce predation.
Ocean Acidification	A process by which the atmospheric carbon dissolves in the ocean, reacts with water molecules and produces carbonic acid. Acidification has an impact on marine life.
Organic Load or Nutrient Load	The accumulation of organic matter or nutrients in a given area or on a given surface.
Pathogen	Refers to infectious bacteria, viruses, or parasites that cause disease (pathology) in a living host. Not all bacteria, viruses or parasites are pathogens. Many pathogens are common and naturally present in the ecosystem.
Salmonid	A group of fish that includes salmon, trout, and char, belonging to the taxonomic family of Salmonidae.
Sea lice	Several species of small parasitic crustaceans commonly found on finfish in the marine environment, but not found in the freshwater environment.

Sediment Sulphide Concentration	Sediment sulphide concentrations help determine the health of the benthic environment in soft-bottom ecosystems.
Seed or Spat	Seed or spat refer to fertilized shellfish larvae found in the water column. A seed or spat collector is an underwater device used to collect shellfish larvae for later use in aquaculture facilities.
Single-year-class	Makes reference to the grouping of fish based on their time spent within the marine environment.
Siting	Process during which a site application is considered for aquaculture by regulatory departments and agencies; many criteria are used to determine if a site is suitable for aquaculture. Conditions can be identified at this stage and imposed later in the terms of the licence.
Smolt (or Juvenile)	A smolt is a juvenile salmon that has completed rearing in freshwater and migrates into the marine environment. Smolt vary in size and age depending on the species of salmon.
Soft and hard ocean substrate	Soft refers to seabed types that can be sampled using sediment grab devices (e.g., gravel, sand, or mud). Hard seabed types cannot be sampled using sediment grab devices (e.g., rock or shell) and are usually monitored through video transects generated by an underwater camera.
Tarpaulin	Tarp-like systems used in grow-out sites to help administer sea lice bath treatments; the tarp surrounds the net cage and keeps the pest control product in to ensure that the fish are treated.
Well-boat	Specialized boats used to help administer sea lice bath treatments; less labour-intensive method of administering sea lice bath treatments than using tarpaulins.

Source: Adapted from the Food and Agriculture Organization of the United Nations, ***Glossary of Aquaculture***. Also based on information from DFO's website.

APPENDIX B: Witnesses

March 31, 2015

Canadian Aquaculture Industry Alliance
Ruth Salmon, Executive Director

Terry Ennis, President, Board of Directors Executive

Pamela Parker, Member, Board of Directors Executive and Government Relations Committee

Fisheries and Oceans Canada
Eric Gilbert, Director General, Aquaculture Management, Ecosystems and Fisheries Management

Kevin Stringer, Senior Assistant Deputy Minister, Ecosystems and Fisheries Management

Jay Parsons, Director, Aquaculture Science, Ecosystems and Fisheries Management

March 24, 2015

Fisheries and Oceans Canada
Stewart Johnson, Science Section Head, Aquatic Animal Health, Pacific Region

Susan Farlinger, Regional Director General, Pacific Region

'Namgis First Nation
Debra Hanuse, Chief

British Columbia Ministry of Agriculture
Gary Marty, Fish Pathologist, Animal Health Centre

As an Individual
Alexandra Morton

Watershed Watch Salmon Society
Stan Proboszcz, Science Advisor

Marine Harvest Canada
Ian Roberts, Communications Manager

March 10, 2015

Fisheries and Oceans Canada
Eric Gilbert, Director General, Aquaculture Management, Ecosystems and Fisheries Management

Trevor Swerdfager, Assistant Deputy Minister, Ecosystems and Oceans Science

Michael Alexander, Acting Assistant Deputy Minister, Ecosystems and Fisheries Management

As Individuals
William Ernst

Michael van den Heuvel, Canada Research Chair in Watershed Ecological Integrity, Canadian Rivers Institute, Department of Biology, University of Prince Edward Island

Ecology Action Centre
Robert Johnson, Sustainable Seafood Program Manager

February 17, 2015

Dalhousie University, Schulich School of Law
William Lahey, Associate Professor of Law

January 27, 2015

Northern Ontario Aquaculture Association
Mike Meeker, President

December 2, 2014

Fisheries and Oceans Canada
Eric Gilbert, Director General, Aquaculture Management

Wayne Moore, Director General, Strategic and Regulatory Science

Kevin Stringer, Senior Assistant Deputy Minister, Ecosystems and Fisheries Management

November 20, 2014

Government of Prince Edward Island
The Honourable Ron W. MacKinley, MLA, Minister of Fisheries, Aquaculture and Rural Development

Richard Gallant, Deputy Minister, Department of Fisheries, Aquaculture and Rural Development

Neil MacNair, Director, Aquaculture Division, Department of Fisheries, Aquaculture and Rural Development

New Brunswick Department of Agriculture, Aquaculture and Fisheries
Kimberly Watson, Regional Director, Regional Development Division of St. George

Joseph LaBelle, Director, Policy Advocacy and Strategic Projects Branch

Katherine Brewer-Dalton, Senior Advisor, Regional Development Division

Mi'kmaq Confederacy of Prince Edward Island
Randy Angus, Director, Integrated Resource Management

Skretting
Steven Backman, Aquaculture Veterinarian

New Brunswick Research & Productivity Council
Benjamin Forward, Head, Food, Fisheries and Aquaculture Department

Atlantic Canada Fish Farmers Association
Betty House, Research and Development Coordinator

Center for Aquaculture Technologies Canada
Debbie Plouffe, Vice-President, Research

Cooke Aquaculture Inc.
Michael Szemerda, Vice-President, Saltwater Operations

Atlantic Salmon Federation
Jonathan Carr, Executive Director, Research and Environment

NSERC Canadian Integrated Multi-Trophic Aquaculture Network
Thierry Chopin, Professor of Marine Biology, University of New Brunswick

Town of St. Andrews
Stan Choptiany, Mayor

As an Individual
William Ernst

Village of Blacks Harbour
Teresa James, Mayor

Conservation Council of New Brunswick
Inka Milewski, Science Advisor

Huntsman Marine Science Centre

Jamey Smith, Executive Director

Table maricole du Québec

Sophie Fortier, Coordinator

Atlantic Canada Fish Farmers Association
Larry Ingalls, Chair and President, Northern Harvest Sea Farms

Murray Hill, Regional Manager

PEI Aquaculture Alliance
Dawn Runighan, President (PEIAA), and Facility Manager, Aqua Bounty Canada

David Lewis, Board Member, Island Oyster Growers Group & Shellfish Grower, Owner

Ann Worth, Executive Director

New Brunswick Professional Shellfish Grower's Association
Martin Mallet, Chair

Confederation Cove Mussel Co. Ltd
Stephen Stewart, President

October 7, 2014

The Georgian Bay Association
Claudette Chabot, Chair, Aquaculture Committee

Bob Duncanson, Executive Director

June 12, 2014

Marine Scotland
Willie Cowan, Head of Performance and Aquaculture

Paul Haddon, Aquaculture Policy Manager

June 5, 2014

Royal Norwegian Embassy
Inger Elisabeth Meyer, First Secretary

May 29, 2014

Potlotek First Nation
Charles Doucette, Fishery Manager

Genome Atlantic
Steve Armstrong, President and CEO

Eel Lake Oyster
Nolan d'Eon, Owner and President

As individuals
James Duston, Professor, Aquaculture, Department Plant and Animal Sciences, Dalhousie University

Jon Grant, NSERC-Cooke Industrial Research Chair in Sustainable Aquaculture, Department of Oceanography, Dalhousie University

Sarah Stewart-Clark, Assistant Professor, Shellfish Aquaculture, Faculty of Agriculture, Dalhousie University

The Ecology Action Centre
Susanna Fuller, Marine Conservation Coordinator

Lobster Council of Canada
Stewart Lamont, Managing Director of Tangier Lobster Company Limited

St. Mary's Bay Coastal Alliance
Brenda Patterson, Member

Nova Scotia Salmon Association
Carl Purcell, Past President

Aquaculture Association of Nova Scotia
Peter Corey, President

Dr. Vicki Swan, Research and Development Coordinator

Robin Stuart, Member

Brian Blanchard, Member

Bryan Bosien, Member

Cooke Aquaculture
Nell Halse, Vice President, Communications

Atlantic Canada Fish Farmers Association
Pamela Parker, Executive Director

Northeast Nutrition Inc.
Tom Taylor, Sales and Technical Support Manager

May 27, 2014

Collier Aqua Service Ltd.
Clyde Collier, Aquaculture Management Consultant

Miawpukek First Nation
Shayne McDonald, Lawyer and Director of Justice

Newfoundland and Labrador House of Assembly
Jim Bennett, member of the House of Assembly for St. Barbe

As individuals
Danny Boyce, Facility and Business Manager, Memorial University of Newfoundland

Cyr Couturier, Research Scientist and Chair, Aquaculture Programs, Fisheries and Marine Institute, Memorial University

Dr. Jillian Westcott, Aquaculture Instructor and Researcher, School of Fisheries, Fisheries and Marine Institute, Memorial University

Municipality of Harbour Breton
Roy Drake, Mayor

Sunrise Fish Farms Inc.
Dr. Laura Halfyard, General Manager

Salmonid Council Newfoundland and Labrador (SCNL)
Donald L. Hutchens, President

Town of St. Alban's Newfoundland and Labrador
Jamie LeRoux, Mayor

Newfoundland Aquaculture Industry Association
Cyr Couturier, President

Miranda Pryor, Executive Director

Darrell Green, Research and Development Coordinator

Newfoundland and Labrador Outfitter's Association
Tony Tuck, Fishing Committee Chair

Badger Bay Mussel Farms Ltd.
Rebecca White, Project Manager

Northern Harvest Sea Farms NL Ltd.
Jennifer Caines, Project Manager

Government of Newfoundland and Labrador
The Honourable Keith Hutchings, Member of the House of Assembly for Ferryland, Minister of Fisheries and Aquaculture

Newfoundland and Labrador Department of Fisheries and Aquaculture
Brian Meaney, Assistant Deputy Minister

Dr. Daryl Whelan, Director, Aquatic Health Division/ Chief Aquaculture Veterinarian

Newfoundland Aqua Service Ltd.
Boyd Pack, Owner and President

Sweeney International Marine Corp. and SIMCorp. Marine Environmental Inc.
Robert Sweeney, President and Senior Project Manager, Head Office

May 6, 2014

Canadian Food Inspection Agency
Dr. Debbie J. Barr, Acting Director, Animal Health, Welfare & Biosecurity Division, Policy and Programs Branch

Dr. Harpreet S. Kochhar, Ph.D., Executive Director, Animal Health Directorate, Policy and Programs Branch

Health Canada
Anatole Papadopoulos, Director, Bureau of Policy, Regulatory and Governmental Affairs, Food Directorate, Health Products and Food Branch

April 29, 2014

Canadian Aquaculture Industry Alliance
Clare Backman, President

Ruth Salmon, Executive Director

April 8, 2014

Tides Canada
Catherine Emrick, Senior Associate, Aquaculture Innovation

SOS Marine Conservation Foundation
Eric Hobson, President

April 1, 2014

Health Canada

Dr. Daniel Chaput, Director General, Veterinary Drugs Directorate, Health Products and Food Branch

Jason Flint, Director, Policy and Regulatory Affairs Division, Pest Management Regulatory Agency

John Worgan, Director, New Substances Assessment and Control Bureau, Healthy Environments and Consumer Safety Branch

March 26, 2014

Union of British Columbia Indian Chiefs
Chief Bob Chamberlin, Vice-President (Kwicksutaineuk Ah-kwa-mish First Nation)

Aboriginal Aquaculture Association
Chief Richard Harry, President

Sable Fish Canada Ltd. (Kyuquot Sound)
Linda Hiemstra, Projects Manager

First Nations Fisheries Council of British Columbia
Jordan Point, Executive Director

Genome British Columbia
Anthony Brooks, Chief Financial Officer and Corporate Secretary

North Island College
Stephen Cross, NSERC Industrial Research Chair for Colleges in Sustainable Aquaculture

K'omoks First Nation
Richard Hardy, Member

Taplow Feeds
Brad Hicks, Executive Vice- President

Town of Campbell River
Walter Jakeway, Mayor

Grieg Seafood BC Ltd.
Barry Milligan, Director Production, Veterinarian

As an individual
Alexandra Morton

Fisheries and Oceans Canada
Laura Richards, Regional Director Science

Andrew Thomson, Area Director, South Coast

Marine Harvest Canada
Clare Backman, Sustainability Programs Director

BC Salmon Farmers Association
Jeremy Dunn, Executive Director

Grieg Seafood British Columbia Ltd.
Stewart Hawthorn, Regional Director

Association for Responsible Shellfish Farming
Dr. Brian Hayden, President

Shelley McKeachie, Member

Dianne Sanford, Member

Island Scallops Ltd.
Robert Saunders, CEO

British Columbia Shellfish Growers Association
Roberta Stevenson, Executive Director

Kuterra Limited Partnership
Garry Ullstrom, CEO

AgriMarine Holdings Inc.
Sean James Wilton, President and CEO

February 25, 2014

Fisheries and Oceans Canada
The Honourable Gail Shea, P.C., M.P., Minister

David Bevan, Associate Deputy Minister

Dave Gillis, A/Assistant Deputy Minister, Ecosystems and Oceans Science

Trevor Swerdfager, Assistant Deputy Minister, Ecosystems and Fisheries Management Operations

February 4, 2014

Environment Canada
Louise Métivier, Director General, Industrial Sectors Directorate, Environmental Stewardship Branch

APPENDIX C: Fact-finding missions

British Columbia – March 24-25, 2014

Creative Salmon, Clayquot Sound (Grow-Out Site)	Tim Rundle, General Manager Lisa Stewart, HR and Communications Manager Ian Francis, Operations Manager Barb Cannon, Biology Manager
Cermaq, Clayquot Sound (Grow-Out Site)	Fernando Villarroel, CEO Laurie Jensen, Communications and Licenses Manager James Costello, Community Liaison Don McIntyre, Regional Production Manager Eric Jensen, Area Manager German Campos, Salt Water Manager Ron Carson, Site Manager
Cermaq, Tofino (Processing Plant)	Fernando Villarroel, CEO Terry Prosnia, Plant Manager James Costello, Community Liaison
Shelter, Tofino	Moses Martin, Chief Coucillor, Tla-o-qui-aht First Nation Wally Samuel, Protocol Committee Member, Ahouset First Nation Fernando Villarroel, CEO, Cermaq Tim Rundle, General Manager, Creative Salmon Lisa Stewart, HR and Communications Manager, Creative Salmon Laurie Jensen, Communications and Licenses Manager, Cermaq James Costello, Community Liaison, Cermaq
BC Centre for Aquatic Health Science, Campbell River	Dr. Sonja Saksida, CEO Dr. Ahmed Siah, Research Scientist Sandra Milligan, Board Member

Marine Harvest Canada, Sayward (Salmon Hatchery)	Clare Backman, Sustainability Programs Director Ian Roberts, Communications Manager Dean Guest, Freshwater Production Manager
Deep Bay Marine Field Station and Centre for Shellfish Research, Vancouver Island University, Bowser	Brian Kingzett, Manager Dr. Greg Crawford, Dean, Faculty of Science and Technology Dr. Helen Gurney-Smith, Research Scientist Stephanie Richards, Facility Coordinator William Litchfield, Director, Advancement and Alumni Claire Vine, Public Education Assistant
Fanny Bay Oysters, Union Bay	Bill Taylor, President, Taylor Shellfish (owner of FBO) Brian Yip, Manager Roberta Stevenson, Executive Director, BC Shellfish Growers Association
Taste of BC Aquafarm, Nanaimo (Land-based Closed-Containment Grow-Out Site)	Steve Atkinson, Owner Janet Atkinson, Owner

NEWFOUNDLAND AND LABRADOR AND NOVA SCOTIA – MAY 26, 28 and 30, 2014

Mike's Place, St. Alban's	Cyr Couturier, President, Newfoundland Aquaculture Industry Association (NAIA) Miranda Pryor, Executive Director, NAIA Jamie Leroux, Mayor, St. Alban's Jerry Kearley, Mayor, Milltown Elizabeth Barlow, Director, Aquaculture Development, NL Department of Fisheries and Aquaculture (DFA) Sheldon George, Production Manager, Cold Ocean Salmon Julia Jensen, Environmental Compliance Manager, Cold Ocean Salmon Jamie Kendall, Production Manager, Newfoundland Aqua Services Trenton Johansen, Operations Manager, Sunrise Fish Farms Jennifer Caines, Project Manager, Northern Harvest Sea Farms
Centre for Aquaculture Health and Development, NL DFA, St. Alban's	Dr. Daryl Whelan, Provincial Aquaculture Veterinarian and Director, Aquatic Animal Health Dr. Amanda Borchart, Aquaculture Veterinarian Elizabeth Barlow, Director, Aquaculture Development
Cold Ocean, Swanger Cove (Salmon Hatchery)	Brian Hull, Senior Manager Jim Murphy, Facility Manager Melissa Burke, Development Officer, Aquaculture, DFA
Northern Harvest Sea Farms Ltd, Fortune Bay (Grow-Out Site)	Jennifer Caines, Project Manager Doug Caines, General Manager Tanya Savory, Site Manager Jason Smith, Skipper Lee Fizzard, Site Worker

Southern Port Hotel, Harbour Breton	Cyr Couturier, President, NAIA Miranda Pryor, ED, NAIA Melissa Burke, Development Officer, Aquaculture, DFA
Aquaculture Facilities and Wharf, Harbour Breton	Cyr Couturier, President, NAIA Miranda Pryor, ED, NAIA Melissa Burke, Development Officer, Aquaculture, DFA
Norlantic, Pleasantview (Mussel Farm and Plant)	Terry Mills, President, Norlantic Miranda Pryor, ED, NAIA
Aquatron Laboratory, Dalhousie University, Halifax	Kevin Dunn, Director, Industry Liaison and Innovation Jim Eddington, Marine Biologist
Acadian Seaplants, Dartmouth	Louis Deveau, Chairman
Cooke Aquaculture, Saddle Islands (Grow-Out Site)	Nell Halse, V-P Communications Jeff Nickerson, Nova Scotia Production Manager John Garland, Southwest Nova Scotia Area Manager Scott Leslie, Site Manager Tim Fraser, Lead Farm Hand
Trellis, Hubbards	Jeff Nickerson, NS Production Manager, CA Scott Leslie, Saddle Islands Site Manager, CA

SCOTLAND AND NORWAY – SEPTEMBER 22 to 26, 2014

Marine Scotland, Victoria Quay, Edinburgh, Scotland	Willie Cowan, Head of Performance & Aquaculture Paul Haddon, Aquaculture Policy Manager Alastair Mitchell, Aquaculture Policy Officer Douglas Sinclair, Aquaculture Specialist, Scottish Environmental Protection Agency Charles Allan, Group Leader, Fish Health Inspectorate
Scottish Salmon Producers Organisation, Perth, Scotland	Phil Thomas, Chairman Scott Landsburgh, Chief Executive Jamie Smith, Technical Executive Alan Balfour, Deputy Managing Director, Loch Duart Ltd, & President, Snow Island
Marine Harvest Scotland, Lochailort, Scotland (Salmon Hatchery)	Steve Bracken, Business Support Manager Allan MacDonald, Hatchery Manager
Marine Harvest Scotland, Loch Shiel, Scotland (Freshwater Grow-Out Site)	Steve Bracken, Business Support Manager Sandy MacKinnon, Site Manager
Glenfinnan House, Glenfinnan, Scotland	Steve Bracken, Business Support Manager
Marine Harvest Scotland, Fort William, Scotland (Processing Plant)	Steve Bracken, Business Support Manager Donald MacIsaac, Plant Manager
Marine Harvest Scotland, Corran, Loch Leven, Scotland (Marine Grow-Out Site)	Steve Bracken, Business Support Manager Chris Ryan, Site Manager
Loch Fyne Oysters Ltd and Scottish Salmon Co., Ardcastle, Loch Fyne, Scotland (Integrated Multi-Trophic Aquaculture Site)	Richard Hunt-Smith, Marketing Executive
Loch Fyne Oysters Ltd, Clachan, Cairndow, Scotland	Richard Hunt-Smith, Marketing Executive
Embassy of Canada, Oslo, Norway	David Sproule, Ambassador Alanna Zulkifli, Trade Commissioner Renato Caldart, Counsellor and Senior Trade Commissioner
Norwegian Ministry of Trade, Industry and Fisheries, Oslo, Norway	Martin Bryde, Director, Fisheries and Aquaculture Marie Bjørland, Fisheries and Aquaculture

Norwegian Seafood Federation, Oslo, Norway	Trond Davidsen, Director of Aquaculture Dr. Ketil, Rykhus, Veterinarian Morten Vike, CEO, Grieg Seafood Geir Molvik, Chief Operating Officer, Cermaq
Norwegian Directorate of Fisheries, Bergen, Norway	Liv Holmefjord, Director General Jens Holm, Director, Aquaculture and Coastal Management Lise Torkildsen, Section Head, Seafood, Norwegian Food Safety Authority Martin Binde, Senior Advisor, Aquatic Animals, Norwegian Food Safety Authority
Institute of Marine Research, Bergen, Norway	Harald Loeng, Research Director Terje Svåsand, Researcher Kari Østervold Toft, Director, Communications
Lerøy Seafood Group, Bergen & Bjørnafjorden, Norway (Headquarters and Grow-Out Site)	Henning Beltestad, CEO

NEW BRUNSWICK, PRINCE EDWARD ISLAND AND QUÉBEC – NOVEMBER 17-19, 2014

Breviro Caviar, Pennfield, NB	Jonathan Barry, President and Managing Director Bill Wentworth, Senior Technician
Cooke Aquaculture, Back Bay, NB	Nell Halse, V-P Communications Michael Szemerda, V-P Saltwater Operations Dr. Thierry Chopin, Professor of Marine Biology, University of New Brunswick
Atlantic Canada Sea Farmer Association	Larry Ingalls, Chair, Board of Directors Bev Bacon, Board Member Nell Halse, Board Member Trevor Stanley, Board Member Pamela Parker, Executive Director Betty House, Research and Development Coordinator
St. Andrews Biological Station, St. Andrews, NB	Dr. Shannon McGladdery, Station Director Alain Vézina, Director of Science, DFO Halifax Office Dr. Shawn Robinson, Senior Researcher, Aquaculture Lara Cooper, Head, Aquaculture & Biological Interactions Blythe Chang, Biologist, Coastal Ocean Research Steven Leadbeater, Biosecurity Officer
Little Shemogue Oyster Company, Botsford, NB	Mitchell Feigenbaum, Owner Paul Firminger, General Manager Amy Firminger, Office Manager
Halibut PEI, Victoria, PEI (Headquarters and Land-based Closed-containment Facilities)	Jim Dunphy, President Bob Johnston, V-P Government Relations Dr. Gerry Johnson, Company Veterinarian

Atlantic Veterinary College, Charlottetown, PEI	Dr. Dan Hurnik, Interim Dean Dr. Robert Gilmour, Vice-President, Research, UPEI Dr. Sophie St-Hilaire, Canada Research Chair in Integrated Health Research for Sustainable Aquaculture Dr. Ian Gardner, Canada Excellence Research Chair in Aquatic Epidemiology Dr. Mark Fast, Novartis Research Chair in Fish Health Dr. Dave Groman, Aquatics Diagnostic Services Anna MacDonald, External Relations Officer
Atlantic Aqua Farms, Orwell Cove, PEI (Head Office and Processing Plant)	Terrry Ennis, President and CEO Bobby MacMillan, V-P Sales
Fermes marines de Gaspé, Newport, QC (Head Office and Plant)	Jean-Philippe Hébert, President
Québec Fisheries and Aquaculture Innovation Centre (Merinov), Gaspé, QC	Julie Boyer, Member, Board of Directors Laurent Girault, Director, Biomass Validation Laurent Millot, Director, Biomass Production Michel Cotton, Acting Director General Luc Leclerc, Project Coordinator Noëlla Coulombe, Laboratory Technician Nadine Renaud, Process Specialist Technician Piotr Bryl, Food Technologist Julie Rousseau, Communications

ST. JOHN'S, NEWFOUNDLAND AND LABRADOR – FEBRUARY 20, 2015

Newfoundland and Labrador Department of Fisheries and Aquaculture, St. John's	Dave Lewis, Acting Deputy Minister Brian Meaney, Assistant Deputy Minister, Aquaculture & Seafood Marketing Dr. Nicole O'Brien, Aquaculture Veterinarian, Aquatic Health Division Steve Moyse, Program & Policy Development Specialist
Ocean Sciences Centre, Memorial University, Logy Bay	Dr. Gary Kachanoski, President & Chancellor Dr. Mark Abrahams, Dean of Science Dr. Garth Fletcher, OSC Director Danny Boyce, Business & Facility Manager Danielle Nichols, Research Marketing Manager Steven Hill, Cold Ocean & Deep Sea Research
Fisheries and Marine Institute, Memorial University, St. John's	Dr. Gary Kachanoski, President & Chancellor Dr. Glen Blackwood, V-P Marine Institute Dr. Mark Abrahams, Dean of Science Dr. Jillian Westcott, Finfish Scientist Cyr Couturier, Research Scientist Heather Manuel, Director, Aquaculture & Seafood Development Keith Rideout, Salmonid Researcher Kim Thornhill, Communications Officer
Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada, St. John's	Lillian Abbas, Acting Director General, NL Region Dounia Hamoudene, Acting Director & Research Scientist Dr. Ben Davis, Division Manager, Aquatic Resources Geoff Perry, Regional Aquaculture Coordinator Kevin Anderson, Fisheries Management Jackie Perry, Strategic Services

SENATE SÉNAT

CANADA

www.senate-senat.ca