



**Mussel Aquaculture Industry Development
Experiences In Different Jurisdictions**

***Literature Review 1 for the
BALTA Golden Mussel Project***

by

Nadine Pinnell

April, 2008

With the Assistance of:

Douglas Gordon, Ph.D.
President
ARMC Ltd

Mike Lewis
Executive Director
Centre for Community
Enterprise

Kenn Renaud
CEO
Blue Frontier Inc.

Evelyn Pinkerton, Ph.D.
Associate Professor
Simon Fraser University

Copyright © 2008, Canadian Centre for Community Renewal (CCCR) on behalf of the B.C.-Alberta Social Economy Research Alliance

For further information, contact the B.C.-Alberta Social Economy Research Alliance, PO Box 1161, Port Alberni, B.C. V9Y 7M1 (tel) 250-723-2296 (fax) 250-248-1957.

Website: www.socialeconomy-bcalberta.ca

e-mail: balta@xplornet.com

Author Information:

Nadine Pinnell is a Masters student in the Resource and Environmental Management (Planning) Program at Simon Fraser University. Her research interests include First Nations economic development and social enterprise, First Nations land use planning and community-based management of natural resources in Canadian and international contexts. She is a member of the project team on the BALTA Golden Mussel Project, which is a cross-cutting project.

This *paper/report* has been produced as part of the research program of the B.C.-Alberta Social Economy Research Alliance (BALTA). Financial support from the Social Sciences and Humanities Research Council of Canada (SSHRC) is gratefully acknowledged.



Social Sciences and Humanities
Research Council of Canada

Conseil de recherches en
sciences humaines du Canada

Canada

Table of Contents

| | |
|---|----|
| Executive Summary | i |
| 1.0 INTRODUCTION | 1 |
| 1.1 Review Context | 1 |
| 1.2 Review Purpose | 1 |
| 1.3 Review Scope | 2 |
| 1.4 Review Format | 2 |
| 2.0 NEW ZEALAND | 3 |
| 2.1 Current Industry Status | 3 |
| 2.2 History of Development | 4 |
| 2.3 Relevant Legislation, Policies and Programs | 5 |
| 2.4 Financial Support to Industry Development..... | 6 |
| 2.5 Coordinating Bodies | 6 |
| 2.6 Technical Assistance..... | 8 |
| 2.7 Training and Education | 8 |
| 2.8 Planning, Research and Advocacy..... | 9 |
| 2.9 Experiences with Social Enterprise | 10 |
| 2.10 Aboriginal Involvement | 10 |
| 3.0 SPAIN | 11 |
| 3.1 Current Industry Status | 11 |
| 3.2 History of Development | 12 |
| 3.3 Relevant Legislation, Policies and Programs | 12 |
| 3.4 Financial Support to Industry Development..... | 12 |
| 3.5 Coordinating Bodies | 13 |
| 3.6 Technical Assistance and Technology | 13 |
| 3.7 Training and Education | 13 |
| 3.8 Planning, Research and Advocacy..... | 13 |
| 3.9 Experiences with Social Enterprise | 14 |
| 4.0 WASHINGTON STATE | 14 |
| 4.1 Current Industry Status | 14 |
| 4.2 History of Development | 15 |
| 4.3 Relevant Legislation, Policies and Programs | 15 |
| 4.4 Financial Support to Industry Development..... | 16 |
| 4.5 Coordinating Bodies | 16 |
| 4.6 Technical Assistance..... | 17 |
| 4.7 Training and Education | 17 |
| 4.8 Planning, Research and Advocacy..... | 17 |
| 4.9 Experiences with Social Enterprise | 18 |
| 4.10 Aboriginal Involvement | 18 |
| 5.0 ATLANTIC CANADA..... | 19 |
| 5.1 Current Industry Status | 19 |
| 5.2 History of Development | 20 |
| 5.3 Relevant Legislation, Policies and Programs | 22 |
| 5.3.1 New Brunswick | 23 |
| 5.3.2 Nova Scotia | 23 |

| | |
|---|----|
| 5.3.3 Prince Edward Island..... | 24 |
| 5.4 Financial Support to Industry Development..... | 24 |
| 5.4.1 New Brunswick | 24 |
| 5.4.2 Nova Scotia | 25 |
| 5.4.3 Prince Edward Island..... | 25 |
| 5.4.4 Newfoundland..... | 26 |
| 5.5 Coordinating Bodies | 26 |
| 5.6 Technical Assistance and Technology | 26 |
| 5.6.1 New Brunswick | 27 |
| 5.6.2 Nova Scotia | 27 |
| 5.6.3 Prince Edward Island..... | 27 |
| 5.6.4 Newfoundland..... | 27 |
| 5.7 Training and Education | 28 |
| 5.8 Planning, Research and Advocacy..... | 28 |
| 5.9 Experiences with Social Enterprise | 29 |
| 5.10 Aboriginal Involvement..... | 30 |
| 6.0 BRITISH COLUMBIA | 30 |
| 6.1 Current Industry Status | 30 |
| 6.2 History of Development..... | 30 |
| 6.3 Relevant Legislation, Policies and Programs | 31 |
| 6.4 Financial Support to Industry Development..... | 32 |
| 6.5 Coordinating Bodies | 33 |
| 6.6 Technical Assistance..... | 33 |
| 6.7 Training and Education | 33 |
| 6.8 Planning, Research and Advocacy..... | 33 |
| 6.9 Experiences With Social Enterprise | 34 |
| 6.10 Aboriginal Involvement..... | 34 |
| 7.0 SUMMARY OF RESULTS | 35 |
| 8.0 LESSONS LEARNED | 42 |
| 9.0 CONCLUSIONS..... | 44 |
| 10.0 RECOMMENDATIONS..... | 44 |
| References | 46 |

Executive Summary

This literature review explores the development of the mussel aquaculture industry in New Zealand, Spain, Washington State, Atlantic Canada and British Columbia. The case study comparison of the experiences of different jurisdictions allows for the identification of key factors important to the expansion and growth of mussel culture. Ultimately, this work will help inform the Golden Mussel Initiative, which aims to support the development of viable mussel aquaculture social enterprises in First Nations communities in BC that incorporate social economy principles.

Each jurisdiction's experience with the various aspects of industry development is detailed. These aspects include: the current status of the industry, the history of industry growth, the regulatory regime, financial supports to industry development, coordinating bodies, technical assistance, training and education opportunities, and research and advocacy. The extent of social enterprise and Aboriginal involvement in the mussel aquaculture industry in each area are also explored.

New Zealand's experience demonstrates the importance of industry coordination and cooperation to growth and expansion. Spain provides an example of regional management of mussel culture as well as of an industry composed of many small producers. Washington State's complex regulatory regime and issues with land use conflicts suggest the need to address these issues in order to facilitate industry growth. Prince Edward Island illustrates the importance of coordinated government support for the industry that includes financial assistance, access to tenures, technical assistance and research and development. Finally, examining the situation in BC shows that there is currently little industry coordination and that government support of mussel culture is not coordinated.

The three major themes which emerge from all of the cases are industry coordination, comprehensive government support and local-level management. These factors should be taken into account in the design of the Golden Mussel enterprises as they will need to compensate for lacks in these areas evident in the current BC situation.

Specific recommendations for the design of the Golden Mussel industry development system are detailed. They include identifying sources of financial support for potential industry participants, incorporating internal and external sources of technical assistance into the design of the GM industry development system, using a coordinated marketing approach for GM mussels, developing coordination and cooperation mechanisms to preserve the ability of smaller operators to participate in the GM industry as it develops and securing consistent sources for Golden Mussel seed stock.

Recommendations for improving the develop environment and supports for the mussel aquaculture industry in BC include developing a better financial support system, supporting the development and funding of effective industry coordination bodies, coordinating and improving technical assistance available to mussel farmers, adopting a regional-level approach to resolving conflicts over the zoning of areas for shellfish aquaculture, and taking a pro-active approach to resolving issues of Aboriginal rights and title claims to foreshore areas.

Mussel Aquaculture Industry Development Experiences In Different Jurisdictions

BALTA Golden Mussel Project - Literature Review 1

1.0 INTRODUCTION

During the past several decades, the extent and occurrence of aquaculture in many parts of the world has grown rapidly (FAO, 2007c). Various countries have developed large aquaculture industries centered on many different species of finfish and shellfish. The development trajectories of the same types of aquaculture industry in different countries will have unique aspects because of differences in the contexts in which they develop. However, they will also have common elements which may suggest factors that are important to the successful development of that particular type of aquaculture industry. Comparing the development of one type of aquaculture industry in different jurisdictions can therefore provide insights into the conditions and factors that may promote the development of the same type of industry in a new location. This literature review focuses on carrying out this type of comparison for the mussel aquaculture industry.

1.1 Review Context

This literature review has been completed for the BC-Alberta Alliance for Research on the Social Economy (BALTA). It is directly linked to the Golden Mussel Initiative which aims to support the potential development of a series of mussel aquaculture social enterprises in First Nations communities on the coast of British Columbia (BC). These enterprises would grow and produce Pacific Golden Mussels, which are a special strain of Blue Mussels (*Mytilus edulis*) developed by Blue Frontier Adventures Inc. (BFI) (Golden Mussel Group, 2000).

Pacific Golden Mussels are currently marketed as a specialty seafood product which command premium prices. It is thought that there is considerable potential for expanding production of the mussels from the current 30-40 tonnes per year (K. Renaud, personal communication, July 17, 2007). The Native Brotherhood of BC (NBBC) is interested in potentially acquiring the rights to the Pacific Golden Mussels and developing mussel aquaculture social enterprises in First Nations communities in order to promote the economic development of these communities. This would mean substantially increasing the scale of the mussel aquaculture industry in BC, which is currently fairly limited.

1.2 Review Purpose

This review is intended to identify key supports that have facilitated the expansion of the mussel culture industry in different countries around the world and to “pinpoint” factors that may be relevant to the eventual implementation of the Golden Mussel project. As such, the extent of social enterprise as an

ownership format in different areas was also investigated. For the purposes of this report, social enterprise ownership formats were considered to include any organizational structure that addressed social goals through commercial business operations, including cooperatives (Restakis, 2006). Finally, the involvement of indigenous peoples in the mussel culture industry in the jurisdictions considered was highlighted where this issue was relevant.

1.3 Review Scope

The amount of time and resources available for completing this review meant that the experiences of all countries which culture mussels could not be considered. With this in mind, the decision was made to carefully select several representative mussel industries and review them in some detail. This review therefore focuses on the experiences of New Zealand, Spain, Washington State and Canada's Atlantic provinces. It also includes a brief overview of the development of mussel culture in BC to date.

New Zealand was chosen as one of the jurisdictions to be investigated because its mussel culture industry has grown dramatically over the past thirty years, making it an international success story in terms of industry expansion. France and Spain have long histories with mussel culture and provide examples of longer-term growth and development in mussel culture. In contrast, the mussel culture industry in Washington State is relatively small and recently developed, which means that it may provide insights into factors that may limit the development of mussel culture with respect to BC First Nations. The experiences of some of the Atlantic Provinces may also reveal such insights regarding constraints, while Prince Edward Island provides a Canadian example of the successful growth and development of a vibrant mussel culture industry.

Aquaculture is not the only means of mussel production used around the world. There is also a capture fishery in various countries including France, Denmark and Thailand, which produces mussels for sale (Josupeit, 2005). Although some of the jurisdictions described in this case study produce mussels through the capture fishery as well as through aquaculture, this review focuses only on the mussel culture industry as this is the most relevant to the BALTA Golden Mussel Initiative. The relationship between the capture fishery and aquaculture is beyond the scope of this review, except where it has contributed to the development of the aquaculture industry.

1.4 Review Format

In order to facilitate the comparison of experiences from different jurisdictions, the same format was used in this report to describe the results of the literature search for each jurisdiction. First, the current status of mussel aquaculture in the case study area is described, followed by a brief history of the development of the industry. Relevant legislation and government policies and programs are outlined next as these dictate the environment in which the industry

has developed. Factors that may help facilitate industry development are then described. These include financial support, coordinating bodies, technical assistance and technology, training and education, and planning, research and advocacy. The final sections included in the description of each jurisdiction's experiences are the extent of social enterprise and Aboriginal involvement in the industry. Although these issues may not be directly relevant to the development of mussel aquaculture in some of the case studies, they are relevant to the Golden Mussel Initiative. The hope is that the experiences of other jurisdictions with these issues may provide lessons learned that can help direct the successful development of the First Nation Golden Mussel enterprises in BC.

2.0 NEW ZEALAND

New Zealand's mussel culture industry has grown dramatically over the past thirty years. As such, it provides a good example of successful industry expansion.

2.1 Current Industry Status

The mussel farming industry in New Zealand includes 645 farms occupying almost 5000 ha of water space and producing over 97 000 tonnes of mussels (FAO, 2007c; MFA, 2006). Domestic and international sales of cultured mussels in 2006 totaled over NZ\$224 million (MFA, 2006). The industry employs 2500 people within the country, many of whom are in rural areas where other employment options are scarce.

Most farmed mussels in New Zealand are cultured from wild seed. A few experimental hatcheries are in place but they have difficulty competing, given the relatively low cost of collecting wild seed (FAO, 2007c). Much of the wild seed used in the industry is collected on 90 Mile Beach on the North Island where considerable quantities of newly settled spat on seaweed wash up on beaches at irregular intervals throughout the year (MFA, 2006). Other wild spat is collected in selected bays on the South Island. The mussels are grown on weighted ropes suspended from long lines supported by floats, mostly in shallow coastal waters. A few groups are currently experimenting with offshore mussel cultivation (FAO, 2007c). Most new mussel farms are in the Marlborough Sounds, at the northern end of the South Island, with a smaller proportion in the Coromandel and Hauraki Gulf in the north of the North Island and off Stewart Island (FAO, 2007c; NZ Seafood Industry Council, 2007b).

Mussels were one of New Zealand's most valuable seafood exports in 2006-2007, with a total value of \$184 million NZ (~ \$144 million CDN) (NZ Seafood Industry Council, 2008b). Exports go to over 50 different countries. The United States is the largest export market for New Zealand mussels, accounting for approximately 35% of all exports with the remainder split between a European and Asian countries (NZ Seafood Industry Council, 2007b). Most mussels that are exported are processed to a frozen half-shell product, of which New Zealand

was a pioneer (FAO, 2007c). Organic certification is another area where the NZ industry has led as the country's largest processor and supplier of mussels was one of the first producers in the world to be organically certified (FAO, 2007c).

2.2 History of Development

The mussel industry in New Zealand started as a wild fishery focused on the harvest of native Greenshell™ mussels (*Perna canalicus*). The first efforts to farm the species began in the late 1960s with a few entrepreneurs who experimented with growing mussels on pontoons and concrete rafts (FAO, 2007c; Gibbs, 2006). During the mid-1970s, Fishing Industry Board staff experimented with using the Japanese long line system for culturing mussels in Marlborough Sounds, a technique that was subsequently adopted throughout the industry (Gibbs, 2006). Although commercial mussel farming and processing began in the late 1970s, it did not really expand until the 1980s (MFA, 2006).

A memorandum of understanding with the US Food and Drug Administration in 1980 that allowed the export of NZ shellfish to the United States provided a market for farmed mussels that remained in place even when the domestic mussel market contracted, as it did in 1983 (Gibbs, 2006). In the mid-1980s, mussel farming expanded to new areas including Coromandel and Big Glory Bay (Gibbs, 2006). The volume and value of the industry grew substantially in the 1980s and 1990s—between 1988 and 1996, mussel export volume increased by 473 percent while export value grew by 413 percent (Bess & Harte, 2000). Today, mussel farming is a major part of the seafood industry sector in New Zealand (NZ Seafood Industry Council, 2007b).

Much of the mussel farming industry's spectacular growth and success can be attributed to the "cooperating to compete" model that early producers and processors used (NZSIC, 2007b). They worked cooperatively to fund and direct research on key industry development issues such as improvements in production techniques and market development, sharing the resulting knowledge openly (Jefferies & Liyanage, 2005). Various innovations in production, processing and marketing were the result of industry efforts, facilitating its growth by increasing the long-term competitiveness of NZ farmers in international markets (Bess & Harte, 2000). The development of a frozen half-shell product meant that mussels could be exported anywhere in the world without a loss of quality. At the same time, cooperative marketing and effective product quality management allowed the industry to establish and develop the reputation of the Greenshell trademark until it was internationally recognized.

The character of the industry has changed as it has grown. When the mussel farming industry in New Zealand was first developing, it consisted mainly of individual entrepreneurs and former commercial fishermen (McClintock, Baines, & Taylor, 2000). The ownership of mussel farms changed dramatically as the industry developed. Initially, most farms were owned by "hands-on" operators. The number of such operators decreased considerably as economies

of scale prompted family operators to sell out to large companies who use contract workers to harvest mussels (McClintock et al., 2000). There has also been considerable aggregation of farm and license ownership, with two companies, Pacifica Seafoods Ltd. and Sanford Ltd., in the Marlborough Sounds area now owning over 150 farms between them (McClintock et al., 2000).

Industry growth has not occurred without some hiccups, however. Claims that Lyprinol, which is made from a mussel extract, could cure some cancers along with the mussel industry's rapid growth prompted a "land rush" for mussel farming applications in the late 1990s (Gibbs, 2006). The intensification and expansion of farming efforts attracted opposition from local residents and environmental groups due to concerns over farms' environmental and visual impacts (Bess & Harte, 2000). At the same time, Maori tribes filed a legal claim to ownership of the seabed and foreshore. In 2002, the government imposed a moratorium on the allocation and development of new aquaculture sites in order to allow for the development of new legislation for aquaculture regulation (FAO, 2007c). Amidst great public and political controversy, the Aquaculture Reform Act and Maori Commercial Aquaculture Claims Settlement Act were developed and introduced in 2004, with regulatory reforms coming into effect in 2005 (Tollefson & Scott, 2006). The Aquaculture Reform Act, which was introduced in 2004, addressed community concerns by having regional councils designate Aquaculture Management Areas where new aquaculture development would be permitted while appeasing industry by simplifying the permitting process for new sites and by increasing tenure security by increasing lease terms to 25 years (Tollefson & Scott, 2006). The Maori Settlement Act was a response to a 2003 court decision that found Maori claims to the foreshore had not been extinguished by previous legislation; the new act gave 20% of existing and new aquaculture tenures to the Maori (Tollefson & Scott, 2006).

An emerging challenge that is currently troubling the mussel farming industry is a weakening US dollar and strong NZ dollar. As international seafood sales are generally conducted in US dollars, NZ seafood exports lose value whenever it weakens as their profits are worth less and less in NZ dollars (NZ Seafood Industry Council, 2008a). Given the dependence of the mussel aquaculture industry on export markets, the impacts of this trend could be considerable.

2.3 Relevant Legislation, Policies and Programs

In 2004, New Zealand passed the Aquaculture Reform Act, which amended several existing pieces of legislation that dealt with aquaculture, and created the Maori Commercial Aquaculture Claims Settlement Act (FAO, 2007b). The amended pieces of legislation were the Resource Management Act, Fisheries Act, Conservation Act, Biosecurity Act, and Te Ture Whenua Maori Act.

The amended Resource Management Act provides most of the framework for managing aquaculture in New Zealand (FAO, 2007b). Under its authority, the

Ministry of Conservation is responsible for preparing coastal policy statements, approving regional coastal plans and permits for coastal activities, and other monitoring. The Ministry of Environment is responsible for making recommendations on issues for policy statements, and setting environmental standards while the Ministry of Fisheries keeps a national registry of fish farmers.

Aquaculture is directly managed at the regional and territorial level using regional coastal plans (FAO, 2007b). These plans define zones for aquaculture and set limits on the character, scale and intensity of aquaculture and related industry activities. There are 17 regional local government agencies that control access to aquaculture sites via this mechanism. By concentrating decision-making at the regional level, conflicts with other coastal stakeholders and users can be reduced. The regulatory burden on mussel and other farmers is also reduced as applications and permits for new and existing aquaculture sites are dealt with at the regional level by a single entity.

The Ministry of Agriculture and Forestry, along with Biosecurity New Zealand and the New Zealand Food Safety Authority, are responsible for ensuring food safety in New Zealand and are thus responsible for regulating those aspects of the sale of farmed mussels (FAO, 2007b).

The Maori Commercial Aquaculture Claims Settlement Act of 2004 establishes that 20% of existing aquaculture tenures and 20% of new tenures must be allocated to the Maori (FAO, 2007b; Tollefson & Scott, 2006).

2.4 Financial Support to Industry Development

The Government of New Zealand has a number of programs in place that offer financial assistance for the development of small and medium-sized enterprises. In addition to this, they provide funding for research on various aquaculture-related issues to the NZ Seafood Industry Council (NZSIC, 2007b).

2.5 Coordinating Bodies

The New Zealand Mussel Industry Council Ltd. (NZMIC) is a company collectively owned and managed by mussel producers and processing companies (NZSIC, 2007b). It is the national voice for the mussel industry in New Zealand (NZMIC, 2008). With funding from a compulsory industry levy, NZMIC acts for the benefit of the mussel industry in the following areas: market promotions, research, the environment, public relations and general advocacy. They employ an Executive Officer, Market Promotions Manager, and Research & Environment Coordinator. Two of their key accomplishments have been the development of the internationally-recognized Greenshell trademark and the development of an Environmental Management System for the industry in the late 1990s (NZMIC, 2008). Investigating strategic issues and concerns such as production techniques, environmental management systems, and market research that are generic to the industry cooperatively through the NZMIC

spurred the dramatic growth of the industry in the 1980s and continues to contribute to its success (NZSIC, 2007b).

The New Zealand Seafood Industry Council Ltd. (NZSIC) is a company owned by the seafood industry that looks after the interests of the industry and promotes its growth. They conduct industry-related scientific research, provide advice on policy issues, advocate for the industry's interests in government consultation processes, work to identify and improve international trade opportunities, and provide information and technical assistance on various issues to government and industry (NZ Seafood Industry Council, 2007a).

Shares in the New Zealand Seafood Industry Council are held by Commercial Stakeholder Organizations (CSOs), who also form the bulk of the Council's membership (NZ Seafood Industry Council, 2007a). CSOs are companies or associations owned by rights holders (ie. quota or permit owners) within a particular fishery or aquaculture area. In the case of mussel aquaculture, mussel producers and processors within New Zealand own and collectively manage the company, the New Zealand Mussel Industry Council Ltd (NZMIC Ltd.).

Commodity levies are used to fund the work of the NZSIC and projects done by CSOs such as the Mussel Industry Council (NZSIC, 2007a). A Core Services Levy, which is a percentage of the Declared Port Price and is applied to all producers, is used to fund the services and work of the NZSIC while a Stock Specific Levy is applied only to a specific seafood stock and is used by the CSO for that stock to carry out projects for the benefit of its producers (NZSIC, 2007a).

The New Zealand Aquaculture Council Ltd. was formed from a mix of existing regional and species aquaculture groups in 2007 in order to implement a national strategic development plan for aquaculture developed in 2006 (FAO, 2007c). They are an incorporated society that represents the collective aquaculture interests of the industry in New Zealand as needed (NZMIC, 2008). The NZMIC is one of the shareholders in the aquaculture council, along with bodies representing oyster, abalone, and salmon farmers.

At the regional level, the Marine Farming Association Inc. (MFA) is a subscription based organization representing marine farmers in the top of the South Island of New Zealand (NZMIC, 2008). Much of the marine farming in New Zealand occurs in this area. The MFA began as the Marlborough Sounds Marine Farming Association in 1974, then changed its name to the New Zealand Marine Farming Association in 1986, and finally to its present form with the formation of the New Zealand Aquaculture Council in 2006 (MFA, 2006). The Coromandel Marine Farmers' Association is a similar subscription-based organization representing marine farmers in the Coromandel, Thames and Auckland areas (NZMIC, 2008).

2.6 Technical Assistance

The National Institute of Water and Atmospheric Research is a government-owned company and the largest aquaculture research organization in the country (FAO, 2007c). They have extensive knowledge and practical experience of scientific and planning issues and can provide technical advice and assistance to marine farmers including those involved in mussel culture operations (NIWA, 2007).

The New Zealand Seafood Standards Council is a committee of the NZSIC which is concerned with the assurance of food safety for seafood produced in New Zealand (NZSIC, 2007d). They act as an advisory council to the New Zealand government and are the recognized national technical authority on seafood safety. Members of the seafood industry, including mussel farmers, are provided with information and training on seafood industry by the standards council (NZSIC, 2007d).

The New Zealand Food Safety Authority is the government regulatory body for food safety (NZFSA, 2007). They are responsible for setting standards for food safety and providing regulatory oversight. The arrangements for shellfish food safety testing in New Zealand are unique in that shellfish quality testing programs are funded by industry rather than government (MFA, 2006). An example of such a program is the Marlborough Shellfish Quality Programme (MQSP), an incorporated society that does sampling and testing for water quality and shellfish safety on the South Island where most mussel farming occurs (MFA, 2006).

2.7 Training and Education

New Zealand has an extensive National Qualifications Framework that outlines consistent, nationally-recognized standards and qualifications for various industries including aquaculture. Standards and qualifications for aquaculture are set by the Seafood Industry Training Organization (SITO). SITO is responsible for developing and facilitating training in support of New Zealand's seafood industry (SITO, 2007a). It receives most of its funding from the Government of New Zealand's Tertiary Education Commission, along with some funding from the NZSIC. Aquaculture standards and qualifications cover various technical and practical aspects of mussel farming and other types of aquaculture (NZQA, 2008). SITO pays a direct subsidy to businesses for all standards-based training they provide to employees as well as subsidizing training provided through an outside training provider such as a polytechnic or college (SITO, 2007a).

Various New Zealand educational institutions offer degrees, certificates, or training in aquaculture. The University of Otago offers graduate degrees in aquaculture through their Department of Marine Science while the Auckland University of Technology has an undergraduate Bachelor of Applied Science in aquaculture degree program (SITO, 2007b). The Bay of Plenty Polytechnic and

several other institutions offer National Certificates in Aquaculture (SITO, 2007b). Other training centers offer shorter courses and customized training to aquaculture businesses including mussel farmers.

The training programs outlined above have helped improve skill levels in the aquaculture industry substantially in recent years, leading to improvements in productivity (FAO, 2007c).

2.8 Planning, Research and Advocacy

Government investment in aquaculture research is estimated to be approximately 2% of gross annual production value (FAO, 2007c). Most funding is delivered via a competitive bidding process through the Foundation for Research, Science and Technology. The government-owned National Institute of Water and Atmospheric Research Ltd (NIWA) is the largest aquaculture research organization in the country (NIWA, 2007). They operate two saltwater aquaculture research facilities and have investigated a variety of different aquaculture research topics relevant to the mussel farming industry.

The non-profit Cawthron Institute is also very involved in aquaculture research (FAO, 2007c). It has investigated various aquaculture research topics including selective breeding of greenshell mussels at its saltwater research facility at the northern end of the South Island (Cawthron Institute, 2007).

The New Zealand Seafood Industry Council Science Group uses some of the funds raised by its commodity levy to conduct scientific research on issues that impact the seafood industry, enabling the industry to participate in research planning processes and in the management of fish and seafood resources (NZSIC, 2007c). Particular emphasis is placed on developing capacity within the industry for science services. The group also provides consultancy services in this area.

Seafood Innovations Ltd, a joint venture research consortium company, has been established by the NZSIC and the New Zealand Institute for Crop & Food Research Ltd to promote the development of research relevant to the seafood industry (Seafood Innovations, 2007). The New Zealand Government is a cornerstone investor in the company. They offer funding to industry stakeholders including mussel farmers and research institutions for research and development projects on innovations that will increase the value of seafood products (Seafood Innovations, 2007).

The NZSIC Policy Group provides policy advice to government and to the commercial seafood sector (NZ Seafood Industry Council, 2007a). They advocate for the sector in various government consultation processes.

In 2006, the New Zealand aquaculture industry went through a major strategic planning exercise that resulted in the New Zealand Aquaculture Strategy (Burrell & Meehan, 2006). This laid out ten areas of activity needed to

reach desired growth targets, including promoting investment in aquaculture, promoting Maori success in aquaculture, developing further markets for products, and promoting environmental sustainability in aquaculture (Burrell & Meehan, 2006).

2.9 Experiences with Social Enterprise

Most of the literature reviewed suggested that when the mussel farming industry first developed, it consisted mainly of family-owned farms. There was some mention of informal work sharing arrangements between different farms during the early days of industry development, though no formal cooperative arrangements were identified in this particular paper (McClintock et al., 2000). However, as the industry has developed, ownership of farms and processing operations has become mainly concentrated within a few large companies. A competitive fringe of a few small growers still exists within the industry (Hoagland, Kite-Powell, & Jin, 2003).

References were found to companies that are formed for a particular function which are joint ventures between different individuals or companies; for example, the Golden Bay Ring Road Companies is a group of spat catching permit holders who have agreed to work together for the purpose of catching mussel spat in the Marlborough Sound area (MFA, 2006).

It could also be argued that industry associations such as the New Zealand Mussel Industry Council Ltd. represent a form of social enterprise, as they are companies operated in order to promote overall industry growth rather than simply returning profits to their shareholders.

2.10 Aboriginal Involvement

As described in Section 2.2 and 2.3 above, the Maori Commercial Aquaculture Claims Settlement Act of 2004 paved the way for increased Maori involvement in mussel aquaculture. The act states that 20% of existing aquaculture tenures and 20% of new tenures must be allocated to the Maori (FAO, 2007b; Tollefson & Scott, 2006). It was a response to a 2003 court decision that found Maori claims to the foreshore, where much aquaculture takes place, had not been extinguished by previous legislation (Tollefson & Scott, 2006). This court case was precipitated by the rapid expansion of shellfish aquaculture during the 1980s and 1990s, mostly by non-Maori entrepreneurs and enterprises.

Various references were found to recent Maori involvement in mussel aquaculture ventures. Some of this involvement was through joint ventures focused on new innovations in mussel culture. For example, in 2005, Eastern Sea Farms, a predominantly Maori-owned company, and Bay of Plenty Mussels Ltd, a joint venture between local Maori and Sealord Products applied for permission to development a series of offshore mussel and spat catching farms

in the Bay of Plenty area (Whakatohea Maori Trust Board, 2005). An example of another Maori aquaculture enterprise is the Wakatu Incorporation, which is working with the Cawthorne Institute to develop a commercial scale hatchery for producing mussel seed (Bland, 2003; Hay & Grant, 2004).

Through the settlement of Maori fisheries claims in 1990s and 2000s, Aotearoa Fisheries Limited, which is the largest Maori-owned fisheries company in New Zealand was developed (AFL, 2007). They own a half-share in Sealord Products, which is the largest seafood company in New Zealand. As well, they operate Pacific Marine Farms Ltd, a wholly-owned subsidiary that specializes in the export of raw mussels and oysters. The company provides some technical assistance and support to Maori farmers that supply it with their products.

From all indications, Maori currently play a fairly substantial role in the mussel culture industry in New Zealand. This has been facilitated by cash settlements that enabled the development of large Maori-owned companies in the aquaculture sector (Federation of Maori Authorities, 2007).

.3.0 SPAIN

Spain is a country with a relatively long history of small-scale mussel cultivation that has intensified and become more industrialized over the past 50 years (FAO, 2007a; FAO, 2007d). As such, its development trajectory differs from that of the other jurisdictions examined in this review.

3.1 Current Industry Status

After China, Spain is the second-largest producer of farmed mussels in the world (FAO, 2007d). In 2005, Spain produced approximately 300 000 tonnes (Franco-Leis, 2005). Over 90% of these were Mediterranean mussels (*Mytilus galloprovincialis*) grown in Galicia using raft culture techniques, meaning that mussels are grown on lines hanging from large rafts anchored in shallow estuaries known as *rias*. The mussel culture industry in Galicia in 2005 consisted of 3242 rafts belonging to 2200 owners, with an average of 1.5 rafts per owner (Franco-Leis, 2005). This suggests that the Galician mussel culture industry has not undergone the same concentration of ownership that has occurred in New Zealand. Mussel culture in Spain relies on the use of wild seed (Sanchez-Mata & Mora, 2000). Subsequent to harvesting, Spanish mussels must be depurated (flushed with sterilized water) for 48 hours before consumption.

Unlike many of the other mussel-growing regions reviewed in this study, the majority of the mussels produced in Spain are consumed domestically. Approximately 70% of Spanish mussel production is consumed within the country while the rest is exported, mainly to Italy and France (FAO, 2007d).

3.2 History of Development

Various countries in Europe have been using culture techniques to produce mussels on a small scale for a long time. In Galicia, Spain, farmers began culturing Mediterranean mussels (*Mytilus galloprovincialis*) in the early 1900s on poles and floating structures (FAO, 2007a). Raft culture techniques were introduced to the area in 1946, but larger-scale development of the industry did not occur until the 1970s (FAO, 2007d). Raft technology has been changing and improving since its introduction in the area (Sanchez-Mata & Mora, 2000).

3.3 Relevant Legislation, Policies and Programs

Under Article 148.1.11 of the Spanish Constitution, management of shellfish farming and aquaculture is taken almost entirely out of the hands of the central state and is left to regional authorities (FAO, 2007d). The General Secretariat for Maritime Fisheries (SGPM) provides information and coordination to these regional authorities on any issues related to aquaculture arising from Spain's involvement in multilateral organizations (FAO, 2007d). Various producers' associations (detailed below in section 3.5) provide leadership for mussel culture at the regional level.

Various laws and regulations at the national and regional level apply to mussel culture. At the national level, applicable regulations include the Law on Marine Aquaculture and Law of the Coasts (FAO, 2007d). Where regions have created their own regulations regarding marine aquaculture, these supersede the national legislation detailed above.

In Galicia, the raft technology used for mussel farming is subject to certain regulatory limits in terms of size and density of mussel production. Rafts must be no more than 500 m² in area, and they can only have up to 500 ropes seeded with mussels hanging from them (Franco-Leis, 2005).

Permits for new shellfish aquaculture installations or leases are generally obtained within an average of one to two years after application (Sanchez-Mata & Mora, 2000). Applicants are generally granted a 10-year concession, which can be renewed in 10-year periods for a maximum of 50 years.

3.4 Financial Support to Industry Development

The Spanish government seems to have recognized the importance of mussel and other types of aquaculture to their economy by investing funding in supporting the growth and expansion of this sector. This funding is provided through the Financial Instrument in Support of Fisheries (Instrumento Financiero de Orientacion de Pesca), and includes subsidized projects centred on expanding and modernizing aquaculture in the country (FAO, 2007d). The Food and Agricultural Organization of the United Nations (FAO, 2007) reports that these investments have increased the pace of aquaculture development in the country.

3.5 Coordinating Bodies

The “Organizacion de Productores Mejilloneros de Galicia” (OPMEGA) is one of the main mussel producers’ organizations in Galicia. Legally established in 1996, when it replaced an earlier producers’ organization, it includes 19 smaller mussel producers’ associations distributed throughout the region (Blue Seed Project, n. d.). Other producers associations are the Federacion de Asociaciones de Mejilloneros de Arosa y Norte and the Asociación Gallega de Mejilloneros (FAO, 2007d). The Asociación de productores del Golfo de Sant Jordi and Union Mejillonera del Puerto de Valencia are seafood producers’ associations from Catalunya and Valencia that include mussel producers in those regions (FAO, 2007d).

3.6 Technical Assistance and Technology

Various institutions work to improve and manage the quality of Spanish seafood products including mussels. In 2003, AENOR (Spanish Association for Standardization and Certification) was created. It has established documentation on the Processes and Products of Aquaculture and an Aquaculture Standardizing Technical Committee in order to promote the standardization and quality management of aquaculture species (FAO, 2007d).

The Spanish General Secretariat for Maritime Fisheries developed training modules for aquaculture managers and technicians focused on environmental management systems (FAO, 2007d).

3.7 Training and Education

Although there is demand for educated professionals to work in Spanish aquaculture businesses, no general degree in aquaculture is offered by any Spanish university (FAO, 2007d). Many universities do offer specialization, graduate or masters degree courses that are related to aquaculture. As well, several professional training courses include aquaculture studies. One can take a two-year course in order to become certified as an Operations Technician in Aquatic Cultivation or an Aquatic Production Technician (FAO, 2007d).

3.8 Planning, Research and Advocacy

In Spain, the General Secretariat for Maritime Fisheries and that National Advisory Board for Marine Aquaculture finance aquaculture research projects that are proposed by individual regions and carried out at universities within those regions (FAO, 2007d). The National Food and Agriculture Research and Technology Institute in Madrid does aquaculture research which is mainly related to pathology.

The Spanish Aquaculture Observatory is a coordination body created in 2002 to promote research and development activities related to aquaculture and

to facilitate the exchange of information between researchers, government, organizations, and enterprises (FAO, 2007d).

3.9 Experiences with Social Enterprise

Spain has a long history of cooperative activity in various sectors, including fisheries. Little specific information on mussel culture cooperatives in the region was found¹. However, one paper suggested that since aquaculture is a relatively new activity, it may initially be viewed with some suspicion by older, established fishing cooperatives who may be concerned that it will compete with fisheries (Jordana i de Simon, R., 1999). A case in the Catalonia region showed that some fishing cooperatives had gotten past this suspicion and were beginning to explore and invest in shellfish aquaculture as an alternative or complementary livelihood option to fishing (Jordana i de Simon, R., 1999).

4.0 WASHINGTON STATE

Washington State is the mussel aquaculture area which is in the closest proximity to British Columbia. As such, it is logical to assume that some characteristics of the context in each area are similar, and that insights from the development of the mussel culture industry in Washington will be relevant to the BC experience.

4.1 Current Industry Status

The mussel culture industry in the western United States is not very large. A total of 28 farms in the entire country produced 5.6 million lbs of food-size mussels for a value of \$5 million USD in 2005 (USDA, 2006). In 2005, eight Washington State farms produced 2.4 million lbs of food size mussels, valued at \$3.3 million USD. A single farm in the state also produced mussel larvae and seed (USDA, 2006). Other states involved in mussel farming include Maine, Alaska, California, Massachusetts, New Hampshire and Rhode Island.

Mussel farming in Washington State is done using raft culture rather than long lines, as this reduces conflict with thousands of sea ducks that migrate through the area each year (Jefferds, 2005). By using rafts, growers can protect mussels from predation by suspending nets around the edge of the rafts. Two species are grown—native Penn Cove Mussels (*Mytilus trossulus*), which are subject to summer mortality elsewhere on the coast, and Mediterranean (warm water) mussels (*Mytilus galloprovincialis*) (Jefferds, 2005). Wild mussels are grown using wild seed collection while the Mediterranean stock are started in hatcheries from brood stock from the previous year (Jefferds, 2005).

¹ This may be because more specific information on mussel culture in the area is written in Spanish, and therefore could not be accessed by the researcher.

4.2 History of Development

The aquaculture industry in the United States is still relatively small in comparison to the rest of the world and mussel farming accounts for only a small proportion of that amount (Laszczak, Papp, Shuman, & Sreenath, 2004).

Between 1998 and 2005, the number of mussel farms in Washington State increased by two, suggesting that the industry has not been experiencing rapid growth (USDA, 2006). As outlined in the section below, onerous governmental regulation is one factor that seems to be inhibiting industry growth. Riparian land owner objections to the expansion of mussel farm sites are another major factor restricting industry development (Jefferds, 2005). This may reflect a general shift from a working waterfront to a more gentrified shoreline, with increasing numbers of residents moving to the area because of its natural beauty rather than because they work in maritime sectors.

Industry growth has also been limited by a lack of integrated coastal planning and urbanizing shorelines, resulting in decreasing water quality in shellfish growing areas due to increases in storm water and agricultural runoff. Between 1985 and 2002, 25% of the commercial shellfish growing areas that had been classified as approved for direct shellfish harvest were downgraded (Dewey, Bunsick, Moyer, & Plauché, 2007). This trend has recently reversed, but it highlights the importance of comprehensive planning to set aside areas for shellfish growing and of enhanced legislation to protect water quality.

4.3 Relevant Legislation, Policies and Programs

Legislation at the federal level in the United States addressing aquaculture includes the Magnuson Stevens Fishery Conservation and Management Act of 1996, the Endangered Species Act of 1973, the Coastal Zone Management Act of 1972, the Lacey Act, and the National Aquaculture Act of 1980 (Laszczak et al., 2004). The National Aquaculture Act initiated a national aquaculture development plan and was intended to promote and support the advancement of aquaculture in the United States. Many federal agencies have regulations pertaining to aquaculture including the National Oceanic and Atmospheric Agency (NOAA), the Environmental Protection Agency, the U.S. Department of Agriculture, the U.S. Navy and the U.S. Army Corps of Engineers. No single agency has been designated as the lead federal agency for aquaculture. This has resulted in a complicated approval process for new aquaculture operations as they require permission from all of the above agencies as well as the relevant state regulatory agencies (Laszczak et al., 2004). A comparative study of aquaculture policy found that Washington had a particularly time-consuming and expensive permitting process (Laszczak et al., 2004). This regulatory complexity has likely been a factor in the slow growth of the aquaculture industry in the United States and of the mussel industry in Washington.

At the state level, six acts apply to the regulation and development of aquaculture in Washington state: the Aquaculture Marketing Act of 1994, the Multiple Use Concept in Management and Administrations of State Owned Land Act of 1971, the Aquatic Land Act of 1984, the Shoreline Management Act of 1971, the Water Pollution Control Act, and the Growth Management Act (Laszczak et al., 2004). The Aquaculture Marketing Act specifically encourages the development and expansion of aquaculture within the state. The Washington Department of Natural Resources is responsible for leasing sites for floating shellfish rafts and long lines (Department of Natural Resources, n.d.).

4.4 Financial Support to Industry Development

The U.S. Department of Agriculture (USDA) offers a number of financial supports that aquaculture producers can access through its Rural Development division. For example, the Business and Industry Guaranteed Loan Program provides guaranteed loans up to \$10 million to aquaculture businesses for business development or expansion including the purchase of land and equipment (USDA, 2007a). Aquaculture operators are eligible to access a number of loans available for farmers through the USDA Farm Services Agency, including direct and guaranteed loans for farm ownership, operation and emergencies (Regulatory and Federal Assistance Division, n.d.; USDA, 2007b). Federal agencies other than USDA that offer loans to aquaculture producers include the Small Business Administration and the Economic Development Administration (McVey, 1991).

Mussel farmers can also access financial resources at the state level. Through the Washington State Department of Community, Trade and Economic Development, they can access supplemental financing for business expansion and development through the Coastal Loan Fund to a maximum of \$150,000 (Washington State, 2007).

Other than loans, shellfish farmers can also access grants for specific types of projects. Through the U.S. Department of Agriculture's Rural Development Program, shellfish farmers are eligible to apply for Value-Added Producer Grants, which can be used for working capital and planning activities for marketing value-added agricultural products (USDA, 2007c). Grant funds must be matched 1:1 by non-grant funds. Through the Small Business Innovation Research program, farmers can access seed capital for researching and testing a technological innovation (USDA, 2008).

4.5 Coordinating Bodies

Founded in 1930, the Pacific Coast Shellfish Growers Association (PCSGA) represents shellfish growers in Alaska, Washington, Oregon, California, and Hawaii (Pacific Coast Shellfish Growers Association, 2007). They serve as the main coordinating and advocacy body for shellfish farmers in these states. They are funded through member dues, which are currently 1% of

farmgate sales or a minimum of \$200 annually (Pacific Coast Shellfish Growers Association, 2007).

4.6 Technical Assistance

Mussel farmers can access technical advice on business development through the Washington Department of Community, Trade, and Economic Development, the USDA Extension Service and the Washington Small Business Development Centers (McVey, 1991).

The Office of Shellfish and Water Protection within the Washington State Department of Health provide shellfish safety certification and growing area classification services to local shellfish growers (DOH, 2007).

4.7 Training and Education

There do not seem to be extensive training and education opportunities relevant to mussel culture available in Washington. The University of Washington College of Ocean and Fishery Sciences offers a few courses on the biology of shellfish and on biological and ecological aspects of aquaculture (University of Washington, 2007). The Peninsula College Center for Aquaculture Training in Port Angeles states that they intend to meet needs for traditional and non-traditional training in aquaculture; however, their list of workshops currently on offer focus on finfish rather than shellfish aquaculture (Peninsula College, 2006).

4.8 Planning, Research and Advocacy

Several government agencies and educational institutions in Washington are involved in research related to mussel and shellfish aquaculture. These include the Washington Department of Fish and Wildlife's Fish and Shellfish Science division and the University of Washington (WDFW, 2007). The Western Regional Aquaculture Center supports regional research on aquaculture among 12 western states including Washington (WRAC, 2005).

The Sea Grant program under NOAA provides grant funding for marine-related research, outreach, and education projects to various institutions throughout the country. Past projects related to shellfish aquaculture funded by Sea Grant Washington include shellfish growers' workshops, research projects on specific scientific or technical aspects of shellfish culture, and develop and communication of shellfish culture best practices (Washington Sea Grant, 2007).

Begun in 1995, the Pacific Shellfish Institute (PSI) is a non-profit organization created to develop and disseminate scientific and technical information of value to the general public, shellfish farmers, and public officials in connection with shellfish-related environmental and animal/human health and safety issues (Pacific Shellfish Institute, 2006). Many of the projects PSI undertakes are publicly funded and are done in partnership with various

government agencies and bodies (Pacific Shellfish Institute, 2006). In a report released in 2006, PSI outlined strategic goals and priorities for the West Coast shellfish industry in the areas of research and education that had been identified in a series of meetings with industry stakeholders. Many of these priorities, such as increasing opportunities for aquaculture training and education, coordinating marketing efforts, or developing techniques for increased production of domesticated shellfish species, would support the further development of the Washington mussel farming industry (Pacific Shellfish Institute, 2006).

In addition to advocacy work done by the PCSGA, the Pacific Aquaculture Caucus also advocates for aquaculture, including shellfish culture, in Washington State. It was created to provide a credible voice for aquaculture in the Pacific region of the country, providing coordination and leadership to support the economically viable and environmentally responsible development of aquaculture (Pacific Aquaculture Caucus, 2007).

A recent development that could affect future marketing efforts of mussel farmers in Washington State and Canada is the World Wildlife Fund's (WWF) Molluscan Aquaculture Dialogue. This series of regional meetings with stakeholders is expected to lead to the development of standards and best practices for mollusc aquaculture that reduce or mitigate its environmental and social impacts (WWF, 2007a). A voluntary certification program for farmers of different types of shellfish including mussels would then be developed based on these standards (WWF, 2007b). Given the growing importance of "green" marketing, obtaining the proposed certification could be an important marketing tool for mussel growers.

4.9 Experiences with Social Enterprise

The mussel culture industry in Washington State takes place on less than ten mussel farms. Most of these farms seem to be individual or family-owned operations. No records of any mussel growers' cooperatives in Washington were found.

However, a shellfish processing and marketing cooperative for mussels and other species is in operation in Alaska. The Kachemak Shellfish Growers Cooperative in Homer, Alaska includes several individual farmers that market and process the mussels and other shellfish they grow through the coop (Kachemak Shellfish Growers Co-op, 2006).

4.10 Aboriginal Involvement

Various Indian tribes in western Washington State have strong interests in wild shellfish resources, which they have traditionally gathered for food. In 1994, a court ruling upheld the contention that the tribes had a treaty-reserved right to half of the harvestable shellfish in intertidal waters, establishing them as co-managers of the resource with the State (NWIFC, 2007). A 2007 out-of-court

settlement resolved some of the issues around implementing the 1994 court condition as many tribal shellfish lands had been sold to commercial shellfish growers, complicating the issue of tribal access². Under this agreement, tribes agreed to forgo the right to harvest shellfish from commercial growers' beds in exchange for the growers providing \$500 000 worth of shellfish enhancement on public tidelands and for the establishment of a \$33 million trust for the tribes to acquire and enhance other tidelands for their own exclusive access (NWIFC, 2007).

As the above agreement suggests, the focus of most tribes' activities around shellfish has been on the collection and enhancement of wild shellfish. References were found indicating the involvement of various tribes, such as the Lummi Nation, in aquaculture activities focusing on species such as oysters and clams rather than mussels (Lummi Nation, 2008). In general, the focus of most Aboriginal groups seems to be on the wild shellfishery and on beach aquaculture. The level of opposition to shellfish aquaculture expansion by riparian land owners may be one factor that has influenced this focus.

5.0 ATLANTIC CANADA

The Atlantic Provinces are home to the largest mussel aquaculture industry in Canada, on Prince Edward Island (PEI). This alone makes them an ideal jurisdiction to consider when identifying factors that have promoted the development and success of mussel aquaculture in other areas. Variation in the extent of mussel aquaculture in other provinces in the region means that it is possible to compare their experiences to that of PEI in order to try to pinpoint specific supports that led to the industry's success in PEI.

5.1 Current Industry Status

Along with oysters, mussels are one of the most common shellfish species raised in the Atlantic region of Canada. In 2004, mussels accounted for 33% of volume and 13% of value in aquaculture production in Atlantic Canada (ACOA, 2006a).

Prince Edward Island is the leader in mussel production in the region and in Canada, producing 17 324 tonnes for a total value of \$22.8 million in 2006 (DFO, 2007b). Newfoundland has the next highest level of production at 3 200 tonnes of mussels for a value of \$7.8 million in 2006 (DFO, 2007b). Production values for Nova Scotia and New Brunswick are not available for 2006 but in 2005, Nova Scotia produced 2 300 tonnes for a value of \$3.06 million while New Brunswick produced 500 tonnes for a value of \$550 000 (DFO, 2007a).

² Under U.S. law, private ownership extends to the low-tide mark rather than the high-tide mark as it does in Canada.

As the above figures suggest, Prince Edward Island is responsible for approximately 80% of Canada's farmed mussel production (ACOA, 2006b; Nova Scotia Agriculture and Fisheries, 2005). The sector employs between 1500 and 2000 people in the province on farms and processing plants (Warris, 2007). Mussel leases³ account for 10,300 acres of the province and are concentrated along the northern and eastern coasts of the province (PEIAA, 2007).

Mussel culture in Atlantic Canada uses suspended culture techniques to grow blue mussels (*Mytilus edulis*). Wild seed or spat is collected in suitable areas, and then mussels grow out in socks or on ropes attached to long lines. Mussels are typically harvested 18-24 months after the grow-out phase.

More than 90% of both finfish and shellfish aquaculture production in the Atlantic region is exported to the United States—primarily to Massachusetts, Maine, New York, Connecticut and New Jersey (ACOA, 2006a). The competitive advantage of the Atlantic region in terms of their quick and easy access to consumers with high incomes in the northeastern United States has been an important factor in industry development and growth.

5.2 History of Development

The mussel-growing industry on PEI has grown enormously since its beginnings in the 1970s, when it was introduced on an experimental basis (PEIAA, 2007). Production has increased from only 88,000 lbs in 1980 to 37 million pounds in 2002 (PEIAA, 2006). The landed value of mussels increased from \$1.7 million in 1987 to \$16.8 million in 1999 and now to \$22.8 million in 2006 (Canmac Economics, School for Resource and Environmental Studies, Enterprise Management Consultants, & Secretariat of the Atlantic Coastal Zone Information Steering Committee, 2002; DFO, 2007b). Overall, the industry grew relatively slowly in the 1980s, with rapid growth in the 1990s (PEIAA, 2007),

A close relationship with and support from the PEI government initiated many of the major developments in the industry (PEIAA, 2007). A comprehensive development plan from the PEI Fisheries Department and readily available water sites through the federal Department of Fisheries and Oceans (DFO) were key factors in facilitating the establishment of mussel farming in the province. Grant money available for research and development through the Atlantic Canada Opportunities Agency allowed for experimentation in determining the most efficient systems for setting, tending and harvested mussel long lines, which was important in increasing industry productivity (Porter, 2005). The availability of loans for new boats and mussel-specific gear in the initial period of industry development was vital, as was technical assistance from various levels of

³ Mussel farmers must lease the waters in which they wish to grow mussels from the government as these areas are technically Crown land.

government. A well-developed lease zoning policy in the 1980s also helped facilitate industry growth (PEIAA, 2007).

As the industry has developed, it has also become more consolidated as independent growers sell out to larger companies (Porter, 2005). Another change is that as most of the PEI's usable mussel-growing waters are now being used; future opportunities within the province are concentrated in the area of offshore mussel production (DFO, 2006).

The industry is currently facing challenges from invasive tunicates, which are spreading within PEI and creating issues for local mussel farms (CBC, 2006). The species grow on mussels suspended in the water, increasing the growing time required by the mussels as well as the amount of labour required for their harvest. They do not kill the mussels, but they do slow mussel growth, extending the 12-month growth cycle by four to five months as well as increasing the difficulty of harvesting the mussels.

Another issue currently affecting the industry is the availability and success of mussel seed. For example, seed purchased from New Brunswick for grow out on PEI mussel leases experienced high (90-100%) mortalities in 2003 (ACRDP, 2004). The purchase of off-Island mussel seed was prompted by shortages in native mussel seed on Prince Edward Island itself.

Nova Scotia was involved in the development of mussel farming techniques in the 1970s and '80s (Nova Scotia Agriculture and Fisheries, 2005). The development and growth of the overall aquaculture industry in the province over the past twenty years has been hindered by a high failure rate for new farms, which is attributed to factors such as the challenging regulatory climate, inadequate screening of proponents for funding programs, and the desire to fast-track heavily subsidized proposals (Nova Scotia Agriculture and Fisheries, 2005). However, the shellfish aquaculture industry has shown recent growth in the province, with the value of shellfish production increasing from just over \$3 million in 1998 to \$10 million in 2004 (ACOA, 2006a).

In an aquaculture development strategy released in 2005, the government of Nova Scotia identifies the following factors as issues that continue to affect the industry: an onerous and expensive licensing system, insufficient lease tenure period, and the inability to access capital or support programs offered to other industries such as agriculture (Nova Scotia Agriculture and Fisheries, 2005). The strategy is cited as one tool for addressing some of these issues. Seed stock supply has also been a problem for the industry in Nova Scotia, with poor coordination between hatchery production and available growout sites resulting in an oversupply or undersupply of seedstock drastically affecting prices (Nova Scotia Agriculture and Fisheries, 2005).

Mussel culture in New Brunswick began in the late 1970s (DFAA, n.d.). It is concentrated in the northeast portion of the province, mainly in the Lameque

and Shippagan areas. Finfish aquaculture in the province has grown more quickly than shellfish aquaculture.

5.3 Relevant Legislation, Policies and Programs

The tangle of provincial and federal jurisdiction over various aspects of shellfish aquaculture is complex, and has resulted in a regulatory burden that threatens to overwhelm the individual growers who represent the majority of the industry. Various attempts have been made to address the overlapping jurisdictions. In 1986, the First Ministers issued a statement of national goals and principles for aquaculture (Howlett & Rayner, 2004). A series of memoranda of understanding between federal and provincial governments were subsequently developed and signed in order to clarify the working relationships between each province and Ottawa. In most cases, the federal government retained the mandate for the protection and conservation of wild stocks and sanitation, while the provinces were given control over licensing, operating practices, and the size and location of facilities.

There is no specific legislation addressing aquaculture at the federal level; instead, it falls under a patchwork of legislation developed for other purposes. This includes the Fisheries Act, Canadian Environmental Assessment Act, Navigable Waters Protection Act, Environment Act, and the Species at Risk Act. The Department of Fisheries and Oceans (DFO) was designated the lead agency for aquaculture in 1984, thus grouping aquaculture with capture fisheries rather than with other types of farming where some have argued it belongs (Howlett & Rayner, 2004). Via the Fisheries Act, DFO has significant abilities to deny or require modification for proposals for new or amended mussel leases if there is the possibility of harmful alteration, disruption or destruction of fish habitat (Government of Canada, 2007). Through the Navigable Waters Protection Act (NWPA) and the Canadian Environmental Assessment Act (CEAA), DFO can also require an environmental assessment for new aquaculture leases (Howlett & Rayner, 2004). As all of these pieces of legislation allow for extensive administrative discretion in their application, there is often little transparency in government decisions. DFO's ability to cause significant delays in the approval of new shellfish leases has resulted in industry calls for the implementation of a "one stop shopping" approach to leasing (Howlett & Rayner, 2004).

The federal government is also involved in shellfish aquaculture regulation in the areas of sanitation and food safety. The Canadian Shellfish Sanitation Program (CSSP) is jointly administered by DFO, the Canadian Food Inspection Agency, and Environment Canada under the authority of the Fisheries Act, Management of Contaminated Fisheries Regulations, the Fish Inspection Act, and Fish Inspection Regulations (Howlett & Rayner, 2004). The CSSP is a program of water quality monitoring and control of the harvesting, processing, and movement of shellfish for human consumption.

Canadian legislation and policies on shellfish aquaculture have been criticized for placing too much emphasis on substantive instruments for industrial promotion without creating effective procedural instruments for generating industry legitimacy in the eyes of the public (Howlett & Rayner, 2004). As a result, the public image of shellfish aquaculture in Canada has been somewhat tarnished by public controversy over the environmental impacts of finfish farming.

5.3.1 New Brunswick

New Brunswick signed an MOU with the federal government regarding the division of authority over aquaculture in 1989 (Howlett & Rayner, 2004). At the provincial level, shellfish aquaculture falls under the Aquaculture Act, which was passed in 1991 (Government of New Brunswick, 2007). The Act addresses issues such as aquaculture leasing and licensing, industry practices, and regulation enforcement. The Government of New Brunswick wishes to modify the Aquaculture Act as it currently stands in order to reflect industry and technological developments since 1991 and is currently soliciting public input on the proposed modifications (Government of New Brunswick, 2007).

5.3.2 Nova Scotia

In Nova Scotia, the primary legislation governing mussel culture is the *Fisheries and Coastal Resource Act*, which includes specific aquaculture provisions (Nova Scotia Agriculture and Fisheries, 2005). This legislation was developed after a major reorganization of laws related to the fishing and aquaculture industries in 1996 (Howlett & Rayner, 2004). The Act specifies site requirements and harvesting and handling requirements for aquaculture as well as identifying shellfish farming as an industry subject to government subsidies (Howlett & Rayner, 2004). The *Environment Act* and *Wildlife Act* also apply to aquatic farming in Nova Scotia. Industry perceives the regulatory regime in Nova Scotia as being arbitrary and expensive (Nova Scotia Agriculture and Fisheries, 2005).

Issues of interagency coordination and communication in promoting aquaculture have been addressed in Nova Scotia by the creation of the Nova Scotia Aquaculture Development Committee in 1993. The committee includes members from various government departments and agencies who have regulatory, development, research and potential funding involvements in aquaculture (Howlett & Rayner, 2004).

Regional Aquaculture Development Advisory Committees (RADACs) have also been established in many areas of Nova Scotia in order to consider applications for new or expanded aquaculture leases (Howlett & Rayner, 2004; OCAD, 2002). Committees include people who represent the interests of the area, including fishers, aquaculturists, recreational boaters, landowners, business operators, and local politicians.

5.3.3 Prince Edward Island

Unlike the situation in many other provinces, the MOU Prince Edward Island signed with the federal government specifies that most aspects of provincial aquaculture will be administered by the federal government under terms of the federal regulatory regime (Howlett & Rayner, 2004). Thus it is DFO rather than the provincial government that is responsible for leasing sites for mussel aquaculture. This may have resulted in fewer jurisdictional overlaps and a smaller regulatory burden for independent growers, which may be one factor in the significant growth of the mussel culture industry in the province.

The Sea Duck Mussel Aquaculture Working Group, which involves participants from the federal and provincial governments and industry, was established on PEI in the mid-1990s to examine the issue of interaction between sea ducks and mussel aquaculture (Howlett & Rayner, 2004). Another relevant advisory group is the Shellfish Classification Working Group, which examines and makes recommendations on water quality issues.

5.4 Financial Support to Industry Development

A gap in industry support identified by the federal Commissioner for Aquaculture Development is the lack of income support and stabilization programs, including crop insurance, that are available to land-based farmers but not shellfish farmers (Howlett & Rayner, 2004). Members of the aquaculture industry have been calling for the development of an Aquaculture Framework Agreement at the federal level to outline a comprehensive set of programs and policies to support the industry for several years but such an agreement has yet to materialize. Another option would be to include aquaculturists under the Agriculture Policy Framework so that they could access the benefits land-based farmers enjoy in the areas of food safety and quality, environmental programs, science and innovation, renewal and business risk management (Nova Scotia Agriculture and Fisheries, 2005).

5.4.1 New Brunswick

The aquaculture industry in New Brunswick has benefited from several large chunks of funding for projects related to industry development. These included the Regional Economic Development Agreement, a federal-provincial agreement signed in 1996 which funded initiatives such as the development of value-added seafood products (NBDFA, 1999). The Economic Development Fund, a 4-year provincial funding program that came into effect in 1996, was another source of funds for shellfish aquaculture development activities. The Strategic Development Fund was another provincial funding program begun in 1994 which provided funds for aquaculture development projects including information workshops and industry missions through the Department of Fisheries and Aquaculture (NBDFA, 1999).

Support for individual mussel growers is available from a variety of different sources. The Fisheries Development Board Loan and Loan Guarantee Funds provides direct loan assistance for new construction and equipment purchases and loan guarantees for working capital purposes (OCAD, 2002). The Community Business Development Corporation has a shellfish development program that offers financial aid which does not need to be repaid for oyster or mussel culture for up to \$50 000 (Holmes, 2003). They also offer personal and commercial loans and assistance with the preparation of business plans for aquaculture ventures. The Atlantic Canada Opportunities Agency Business Development Program provides access to capital via interest-free unsecured loans for small and medium-sized aquaculture enterprises (Lapointe, 2003). Business New Brunswick offers financial help to shellfish growers for fixed assets and cash flow via term loans and loan guarantees (Nazaire, 2003). The New Brunswick Innovation Foundation offers a 30% non-refundable income tax credit of up to \$15 000 per year to eligible investors who invest capital in eligible NB small businesses, including aquaculture operations (Gagnon, 2003).

5.4.2 Nova Scotia

Government agencies that offer business support and lending programs for aquaculture in Nova Scotia include the Nova Scotia Department of Agriculture and Fisheries Loan Board, Agriculture and Agri-food Canada, Atlantic Canada Opportunities Agencies, Farm Credit Corporation, and the National Research Council's Industrial Research Assistance Program (Nova Scotia Agriculture and Fisheries, 2005).

The Fisheries and Aquaculture Loan Board offers direct loans for shellfish stock and related grow-out and hatchery related equipment (OCAD, 2002). Aquaculture working capital loan guarantees for operating costs are also available through the chartered banks. Through support to the Atlantic Canada Opportunities Agency, growers can access non-interest bearing loans to a maximum of \$500 000 for expansion of production facilities, start-ups of new operations, and consultants or marketing studies (OCAD, 2002).

5.4.3 Prince Edward Island

A variety of different programs offer direct financial assistance to the mussel culture industry in PEI. The Shellfish Aquaculture Financing Program provides annual term loans or demand loans in order to facilitate production expansion (OCAD, 2002). The Rental Incentive Program provides a one-time rental subsidy for the establishment or expansion of a business. The Test Production Program provides incentive grants to encourage new developments in seafood processing including packaging and product development (OCAD, 2002).

5.4.4 Newfoundland

The Shellfish Aquaculture Working Capital Fund provides loans of up to 30% of costs to a maximum of \$250 000 for projects related to the production, harvesting and processing of various species including blue mussels (OCAD, 2002).

5.5 Coordinating Bodies

At the national level, the aquaculture industry as a whole is represented by the Canadian Aquaculture Industry Alliance (CAIA), which was formed in 1995. At the provincial level, various aquaculture industry and shellfish grower associations represent mussel farmers. In Nova Scotia and Newfoundland, farmers are represented by the Newfoundland Aquaculture Industry Association and the Nova Scotia Aquaculture Industry Association respectively.

Mussel farmers in New Brunswick are represented by the Professional Shellfish Growers Association of New Brunswick, which was created in 1997 (Professional Shellfish Growers Association of New Brunswick, 2003). As of 2003, they had 47 members, mostly mussel and oyster growers. They are currently looking for new sources of funding. Initially, they were supported by the ACOA but that funding is not ongoing. As shellfish generate fewer revenues than finfish aquaculture, they have found that finding association funding is more difficult for them than it is in provinces where the representative body includes salmon growers (Professional Shellfish Growers Association of New Brunswick, 2003).

The Prince Edward Island Cultured Mussel Growers Association was formed in 1981 with the objective of advancing the promotion and wellbeing of the industry (PEIAA, 2007). Some of their accomplishments include the completion of the PEI Shellfish Environmental Code of Practice in 2002. They currently have over 90 members (PEIAA, 2007). They advocate for the industry and pursue research relevant to its further development. Their current areas of research interest are in the areas of mussel seed, nuisance species and predation, invasive species, bio-security, and water quality (Warris, 2007). Research projects include looking for improvements in seed grading process and the declumping process, doing a general review of husbandry and collection techniques, completing a survey to determine seed requirements, investigating interactions between seed set and the presence of invasive species, and testing alternative sources of mussel seed such as broodstock operations or hatcheries (Warris, 2007).

5.6 Technical Assistance and Technology

At a national level, mussel farmers can access the National Research Council's Industrial Research Assistance Program (NRC-IRAP), which will contribute up to 50% of the costs for projects that stimulate innovation, or the

development of new products and/or processes, in SMEs in Canada (Albert, 2003). They also have advisers who are able to provide expert advice as needed.

5.6.1 New Brunswick

The Trade Assistance Program provides funding for up to 50% of the cost for companies to participate in trade shows and missions related to the domestic and international market (OCAD, 2002). The Fish Laboratory maintained by the province does testing of samples as needed for the aquaculture industry.

The New Brunswick Innovation Foundation supports innovation projects from private companies and individuals through indirect equity investments or equity investments, which are typically up to \$250 000 (up to \$25 000 for company start up) (Gagnon, 2003). They also have a venture capital fund which supports innovative NB companies with unique and commercially viable ideas via early stage capital investments up to a maximum of \$500 000 or 20% of total investment in a company.

5.6.2 Nova Scotia

The Fisheries and Aquaculture Development Program in Nova Scotia offers funding to mussel farmers and others for new and improved harvesting and processing technology or community-based infrastructure (OCAD, 2002).

5.6.3 Prince Edward Island

The Aquaculture Technology Program provides financial incentives of up to \$10,000 for aquaculture operations to develop or adopt new techniques or technologies in order to expand production, reduce production costs or otherwise increase earnings through efficiencies (OCAD, 2002).

In terms of technical assistance for the entire industry, the Mussel Monitoring Program collects and disseminates technical information related to the industry through having dedicated staff who visit spat collection and growing areas to provide relevant information directly to growers (OCAD, 2002).

5.6.4 Newfoundland

Various provincial programs provide support to mussel culture in Newfoundland. The Aquaculture Technology Program provides grants to a maximum of \$10,000 per project for commercial aquaculture operations to evaluate, develop and adopt new techniques and/or technologies that expand production, reduce production costs or increase product quality (OCAD, 2002). The Mussel Production Incentive Program provides grants to mussel growers for new gear that will increase production over previously planned levels (OCAD, 2002).

Other programs are provided to the industry as a whole. Health and veterinary services are provided through an extension service to the finfish and shellfish industries for early detections, prevention and treatment (OCAD, 2002). Market information on major species including blue mussels is researched, collected and distributed. Shellfish Extension Services gather and distribute information on biological/productivity monitoring for the five major mussel aquaculture areas in the province and on quality assurance and management programs (OCAD, 2002).

5.7 Training and Education

The Nova Scotia Agricultural College in Truro is the only institution in Atlantic Canada which offers undergraduate and graduate degree programs in aquaculture (Nova Scotia Agriculture and Fisheries, 2005)⁴. Various other universities and colleges including the University of Prince Edward Island and Memorial University offer undergraduate and graduate students opportunities to do research on aspects of shellfish aquaculture while enrolled in related degree programs.

The Nova Scotia Community College, Shelburne Campus, offers a one year diploma course that trains people in practical aspects of operating an aquatic farm (Nova Scotia Agriculture and Fisheries, 2005). New Brunswick Community College also offers a one year Aquaculture Technician course, though its major focus is on finfish aquaculture (New Brunswick Community College, 2008).

5.8 Planning, Research and Advocacy

The Atlantic Canada Aquaculture Industry Research and Development Network was established in 2002 to provide a unified voice and direction in terms of industry research and development (ACAIRDN, 2007). It is an industry-driven network which began in 2002 with placement of Research and Development Coordinators at each of the major industry associations in the region and in BC. Thus far, it has received funding from the National Research Council and ACOA. An ACAIRDN workshop in 2007 identified deficiency of scientific expertise at Atlantic Canadian universities as a major concern.

Nationally, various sources of funding are available for industry-relevant research and development. DFO's Aquaculture Collaborative Research and Development Program (ACRDP) pairs industry with DFO researchers for projects funded by DFO in an attempt to increase collaboration between the two (DFO, 2008).

⁴ Offered in conjunction with Dalhousie University

On Prince Edward Island, the Aquaculture Research Program provides cost-sharing for applied and developmental research projects initiated by industry associations, private businesses, educational institutions, and provincial government agencies (OCAD, 2002).

The New Brunswick Innovation Foundation provides research and development tax credits for up to 15% of eligible expenditures to aquaculture operations (Gagnon, 2003)

Various educational centres and institutes throughout Atlantic Canada have research and development capabilities that are available and being used for research relevant to the aquaculture industry. These include Dalhousie University, Atlantic Veterinary College, the Bedford Institute of Oceanography, the Bonne Bay Research Station, the Canadian Aquaculture Institute, the Canadian Centre for Fisheries Innovation, the Canadian Institute of Fisheries Technology, the Centre for Aquaculture and Seafood Development, the Coastal Zones Research Institute, the Department of Fisheries and Oceans, the Huntsman Marine Science Centre, Memorial University, the National Research Council's Institute for Marine Biosciences, the Nova Scotia Agricultural College Aquaculture Centre, the PEI Food Technology Centre, the Research and Productivity Council, and the Shippagan Marine Centre(ACOA, 2006b). However, the majority of the aquaculture research currently occurring in the region focuses on finfish rather than shellfish aquaculture.

5.9 Experiences with Social Enterprise

The PEI Business Names Registry (<http://www.gov.pe.ca/corporations/index.php>) does not list any mussel aquaculture cooperatives currently in operation in the province. It does list two oyster culture cooperatives and a cultured fish cooperative as well as several fisheries cooperatives (Government of PEI, 2008). The majority of mussel farms currently operating in the province seem to be family-owned businesses.

The Atlantic Mussel Growers, a company that acted as the processing and marketing arm for many independent growers and its shareholders on PEI, does seem to have acted like a processing and marketing cooperative for local mussel farmers (Atlantic Mussel Growers, 2003). However, in 2004, Atlantic Mussel Growers Ltd., Icewater Mussels Inc., and Ocean Choice International Limited consolidated to form Canadian Mussels Ltd. (CML), which is currently North America's largest value added mussel company (Canadian Mussels Ltd., 2005).

The other example of a social enterprise involved in mussel farming that turned up in this review was St. Anthony Basin Resources Inc.(SABRI), which was first set up to manage an allocation of shrimp for communities in the St. Anthony Basin area of Newfoundland (SABRI, 2007b). They began mussel farming in 2002 at three farm sites. By 2006, SABRI had developed a primary processing plant, selling approximately 60 000 lbs of mussels to local individuals

and businesses and to a secondary processor (SABRI, 2007a). They are located in St. Anthony, Newfoundland.

5.10 Aboriginal Involvement

None of the literature reviewed provided specific examples of aboriginal involvement in mussel aquaculture in Atlantic Canada. The Aboriginal Business Directory (<http://www.ic.gc.ca/app/ccc/srch/cccSrch.do?lang=eng&prtl=1&tagid=&profileId=401&rstBtn.x=>) did not list any Aboriginal businesses in the region that produced mussels. Several First Nations in the area seem to be involved in collecting wild mussels, as a 2003 DFO report refers to the Abegweit First Nation (PEI), Lennox Island First Nation (PEI) and National Council of PEI as holding communal commercial mussel licenses (DFO, 2003).

One reference was found regarding First Nations involvement in other types of aquaculture. The Millbrook First Nation, in Nova Scotia, has built a land-based aquaculture facility for Arctic char (INAC, 2003). The operation is wholly owned by the band, with no outside investors.

6.0 BRITISH COLUMBIA

6.1 Current Industry Status

Almost all shellfish aquaculture in British Columbia currently takes place on the south coast, with the majority of farms located in the Baynes Sound area (McCallum, 2007). Mussels are not a major focus of the industry, which is dominated by beach culture operations producing oysters and clams. Most shellfish farms are small, family-run operations (GSGislason & Associates Ltd., 2004).

The mussels that are grown in BC are primarily blue mussels (*Mytilus edulis*) which are grown from hatchery seed using rafts. In 2006, BC farms produced a total of 250 tonnes of mussels, with a farm gate value of \$1.1 million (DFO, 2007b).

6.2 History of Development

In 1997, a Western Economic Diversification (WED) report suggested that the BC shellfish aquaculture industry had the potential to grow from \$12 million to \$100 million, contributing 1000 additional jobs to the economy (GSGislason & Associates Ltd., 2004). The nature of shellfish aquaculture meant that most of the jobs and economic development would be created in coastal rural areas hard-hit by the decline of the fishery and forestry sectors. This prompted the provincial government to launch the BC Shellfish Development Initiative in 1998, which was intended to facilitate industry growth by doubling the amount of Crown land in shellfish aquaculture leases by 2008 (Ministry of Agriculture and Lands,

2007). The Shellfish Aquaculture Working Capital Fund, which provides loans for shellfish aquaculture entrepreneurs, was also initiated (BC Shellfish Growers Association, 2007). However, despite these efforts, the total wholesale value of shellfish aquaculture in BC in 2006 had only risen to \$33.9 million, far below initial expectations for industry growth (Ministry of Environment, Oceans and Marine Fisheries Division, 2007). This slow growth has been attributed to various factors including “lack of intergovernmental coordination, premature tenure expansion announcements without adequate consultation of local communities, [and] uncertainty surrounding unresolved First Nations’ claims and their impact on the foreshore and coastal waters” (Howlett & Rayner, 2004, p. 171).

6.3 Relevant Legislation, Policies and Programs

The regulatory regime for shellfish aquaculture in BC is extremely complex. The industry is currently subject to 52 different federal and provincial statutes, regulations, policies and guidelines (GSGislason & Associates Ltd., 2004). Under a 1998 Memorandum of Understanding (MOU), the federal government is responsible for protection of wild stocks, navigable waters, and shellfish sanitary regulations while the province has control over licensing, industry management, and industry practices in BC (GSGislason & Associates Ltd., 2004; Howlett & Rayner, 2004). The relevant lead agencies are DFO and the provincial Ministry of Agriculture and Lands (MAL). In practice, this means that shellfish farmers apply to the provincial government for a shellfish aquaculture tenure and license, but that the proposed farm is subject to screening and approval by the federal DFO where there are potential impacts on the marine environment, wild fish, or marine navigation. This jurisdictional overlap has resulted in a large regulatory burden and long delays in licensing that strain the resources of the small aquaculture operations that are common within the industry (GS Gislason & Associates Ltd., 2004; Howlett & Rayner, 2004).

Unlike other coastal provinces, BC does not have an Aquaculture Act, relying instead on a patchwork of existing regulations such as the Wastewater Management Act to direct industry development (Howlett & Rayner, 2004). New programs, such as the BC Shellfish Development Initiative, have focussed on industry promotion, failing to address the need to build shellfish aquaculture industry and policy legitimacy through decision-making and information-sharing processes (Howlett & Rayner, 2004). This has left the industry vulnerable to the loss of public and community support. Indeed, in the Baynes Sound area, where shellfish aquaculture development has been most intensive, opposition to industry expansion has arisen from property owners concerned with its effects on their viewsapes (GSGislason & Associates Ltd., 2004). High profile controversy over the environmental impacts of salmon aquaculture has exacerbated this issue of legitimacy by creating growing concern and opposition to all forms of aquaculture in some segments of the public (GSGislason & Associates Ltd., 2004; Howlett & Rayner, 2004; Rollins & McCallum, 2005). Although deepwater mussel culture techniques have fewer aesthetic impacts than the beach culture of oysters and clams that currently dominates the province’s shellfish aquaculture

industry, mussel growers are still potentially vulnerable to the opinions of a public that often does not distinguish between finfish and shellfish aquaculture or between different types of shellfish aquaculture.

Currently there is no specific environmental management or monitoring system in place for shellfish aquaculture in B.C. Environmental impacts of the industry are covered under the Waste Management Act. The government manages industry practices on the basis of complaints to the Farm Industry Review Board but does not provide any overall guidance in terms of best practices (Deal, 2005; Howlett & Rayner, 2004). The BCSGA developed and published a voluntary Environmental Management Code of Practice (COP) for its members in 2001, but none of its provisions are binding or enforced (BC Shellfish Growers Association, 2006). Environmental groups and members of the public have called for implementation and enforcement of an environmental management system based on the existing COP, as well as for further research on the potential environmental impacts of shellfish aquaculture (Deal, 2005). Meanwhile, industry members have also acknowledged their need to adhere to environmental stewardship standards in order to be able to market BC farmed shellfish as a sustainable seafood product and take advantage of growing international demand for such products (BC Shellfish Growers Association, 2006; GSGislason & Associates Ltd., 2004). The successful New Zealand Greenshell mussel industry is an example of how such “green marketing” can foster industry growth, while the experiences of the BC salmon aquaculture industry provide a cautionary example of how public concern over perceived gaps in government regulation of environmental impacts can threaten industry growth (GSGislason & Associates Ltd., 2004).

The province’s Shellfish Development Initiative, launched in 1998, aimed to double the amount of land available for shellfish tenures in the province (Ministry of Agriculture and Lands, 2007). This has resulted in the development of shellfish pilot projects at 15 sites on the North Coast and Queen Charlotte Islands in cooperation with local First Nations (OCAD, 2002).

6.4 Financial Support to Industry Development

The main financial support instrument at the provincial level is the Shellfish Aquaculture Working Capital Fund, which was created to provide loans of up to \$30,000 for working capital in support of the development of new shellfish farms or the expansion of existing farms (OCAD, 2002). The fund specifically addresses the chronic shortage of working capital in the shellfish aquaculture industry in the province. Although other types of support are available in the province, this is the only initiative that focuses on providing direct support to individual entrepreneurs (Howlett & Rayner, 2004).

6.5 Coordinating Bodies

The BC Shellfish Growers Association (BCSGA) has represented the local shellfish industry for over 55 years (McCallum, 2007). The BCSGA currently includes approximately 150 members, who represent the majority of growers and industry service providers. Over the past few years, they have developed a voluntary Environmental Management Code of Practice and Strategic Plan to stimulate industry growth (BC Shellfish Growers Association, 2006).

6.6 Technical Assistance

The provincial Quality Control program addresses the safety and quality of shellfish products through technical work such as water quality sampling and shellfish growing water classification surveys (OCAD, 2002). Siting advice and technical assistance are also available from provincial staff with expertise in these areas.

6.7 Training and Education

The Center for Shellfish Research at Vancouver Island University (previously Malaysian College) offers support for undergraduate and graduate students interested in research on shellfish aquaculture (CSR, n.d.). They also offer 17 short (1-10 day) courses on various aspects of shellfish farming to people currently involved in the industry or interested in developing a new shellfish venture. They are also able to provide customized training for Aboriginal communities interested in shellfish research. The B.C. Government has given the Center \$3 million in funding to support the development of this training program for First Nations and industry.

6.8 Planning, Research and Advocacy

The provincial government supports a research fund managed by the BC Aquaculture Research and Development Committee which is available to scientists for aquaculture-related projects (OCAD, 2002). The provincial government also provides funding for academic research and training to the University of British Columbia and Vancouver Island University's Centre for Shellfish Research (OCAD, 2002).

The provincial government leads various coastal planning efforts and studies that relate to aquaculture, creating a more secure and certain planning context for industry development (OCAD, 2002). However, it is important to note that in the past these efforts have not always adequately addressed community concerns about shellfish tenure expansion and impacts (mainly visual) (Howlett & Rayner, 2004).

In 2006, the BCSGA appointed a Research and Development Coordinator (McCallum, 2007). The position is currently filled by David McCallum. In the same year, the BCSGA also produced a Strategic Plan which included a section

identifying some of their priorities for research and development (BC Shellfish Growers Association, 2006).

The following research institutions are currently available for or involved in shellfish aquaculture research in B.C.: the Pacific Biological Station - Department of Fisheries and Oceans, the Centre for Aquatic Health Sciences, the Centre for Shellfish Research at Vancouver Island University, which includes the current Canada Research Chair in Sustainable Shellfish Aquaculture, a lab and recirculation facility, and a field site in Deep Bay, and the Pacific SEA Lab (McCallum, 2007).

Several workshops addressing industry research and development priorities have taken place during the past few years. A series of workshops led by the Centre for Shellfish Research identified the following priorities in several different categories (DeJager & Salmon, 2006). In the area of animal science, research on improved survival and growth, higher quality products, and genetic improvements were priorities. The area of environmental interactions, including effects of culture practices, and the integration of industry into regional development, was another focus. In the area of grow-out techniques, technology transfer, economics and business management were concerns while monitoring programs, reliability of water quality indicators, and a strategy for dealing with cadmium were highlighted in food safety area. Improving market intelligence and value-added differentiation were identified in the area of marketing while public perceptions and acceptance of the industry were a concern in the area of social science (DeJager & Salmon, 2006).

The overall perception of the BCSGA is that there is currently sufficient funding available for research but not for industry development (McCallum, 2007).

6.9 Experiences With Social Enterprise

The Malcolm Island Shellfish Growers Cooperative was working to develop an aquaculture venture based around abalone. Unfortunately issues with government permitting and regulations surrounded abalone as a Species at Risk meant that the enterprise had to be abandoned.

6.10 Aboriginal Involvement

Various First Nations groups in B.C. have some degree of involvement in shellfish aquaculture of some sort. Most groups have concentrated on developing operations around the culture of oysters, clams or geoducks rather than mussels. For example, the Tla-o-qui-aht, Mowachaht/ Muchalaht, Hesquiat, Ka:'yu:'k't'h'/Che:k'tles7et'h, Ehattesaht, Toquaht, Uchucklesaht, Ucluelet, and Huu-ay-aht First Nations have all started shellfish aquaculture ventures with the assistance of the Nuu-chah-nulth Seafood Development Corporation (NSDC, 2005). These groups are all members of the Nuu-chah-nulth Tribal Council and

are located on the west coast of Vancouver Island. These operations vary in terms of size, scope, and species farmed. For example, the Huu-ay-aht First Nation has begun an integrated shellfish aquaculture operation which includes culture, processing, and marketing of several species while other ventures focus on production of one or two species (NSDC, 2005). The various operations are also at different stages of development.

On the Central and North Coast, twelve First Nations communities are working with two native organizations, the Turning Point Initiative Society and the Tsimshian Stewardship Committee, to develop shellfish aquaculture in the area through a program of pilot farms, regional business planning and infrastructure development that began in 2003 (Kingzett & Norgard, 2003).

About 8% of the land currently under shellfish aquaculture tenure in B.C. is farmed by First Nations groups (Olding, 2006). There is some suggestion that in some cases First Nations who might otherwise be interested in shellfish aquaculture may lack the financial and technical capacity they need in order to successfully participate in the industry (Deo, 2002). This is presumably the reason for the \$3 million in funding the provincial government has given Vancouver Island University's Centre for Shellfish Research for the development of a training program for First Nations communities interested in shellfish aquaculture and for the shellfish aquaculture industry as a whole (CSR, n.d.).

In addition to the organizations mentioned above, several other First Nations organizations have some involvement with developing or supporting shellfish aquaculture in First Nations communities. These include the Aboriginal Aquaculture Association (AAA, 2007) and the Native Brotherhood of BC, which is a partner in the Golden Mussel Initiative.

7.0 SUMMARY OF RESULTS

As the results of this review indicate, there are some common elements in the development of the mussel culture industry in different parts of the world. Table 1 below summarizes key aspects of the development of this industry in different jurisdictions. This comparison facilitates the identification of key supports to industry development that may need to be in place to stimulate the growth and development of mussel aquaculture in general, and the Golden Mussel aquaculture industry in particular, in BC. As such, these results also lead to recommendations for the design of the Golden Mussel industry development system.

| Industry characteristic | New Zealand | Spain | Washington State | Prince Edward Island | British Columbia |
|----------------------------|---|--|---|--|---|
| Species grown | Greenshell TM mussels (<i>Perna canalicus</i>) | Mediterranean mussels (<i>Mytilus galloprovincialis</i>) | Penn Cove Mussels (<i>Mytilus trossulus</i>) and Mediterranean mussels (<i>Mytilus galloprovincialis</i>) | Blue mussels (<i>Mytilus edulis</i>) | Mainly blue mussels (<i>Mytilus edulis</i>) |
| Culture techniques | - long lines - wild seed | - large rafts - wild seed | - rafts - both wild seed (<i>trossulus</i>) and hatchery (Mediterranean) | - long lines - wild seed | - rafts - hatchery seed |
| Production (tonnes) | - over 97 000 tonnes - most are exported as a frozen half-shell product | - ~300 000 tonnes - most are sold and consumed domestically | - 2.4 million lbs (1088 tonnes) - most sold domestically | - ~17 000 tonnes - almost all exported to the United States | - 250 tonnes of mussels - most are exported to the United States |
| Composition | - considerable aggregation of ownership - large companies who use contract workers for harvest - some small farmers | - many smaller producers - average of ~1.5 rafts per owner in Galicia | - 8 farms in total - individual or family-owned operations | - has become more consolidated as independent growers sell out to larger companies | - mostly small operations |

| Industry characteristic | New Zealand | Spain | Washington State | Prince Edward Island | British Columbia |
|-------------------------|---|---|--|--|--|
| Industry growth | <ul style="list-style-type: none"> - commercial culture began in 1970s - rapid expansion and growth in the 1980s and 1990s - “cooperating to compete” model resulted in cooperative marketing and development of Greenshell trademark and frozen product | <ul style="list-style-type: none"> - history of culture in area - rafts introduced in 1940s - larger-scale development and expansion of the industry occurred in the 1970s | <ul style="list-style-type: none"> - little growth only two farms added between 1998 and 2005 | <ul style="list-style-type: none"> - experimental culture began in 1970s - rapid growth and expansion of industry from late 1980s - government support important to industry expansion: provided effective planning, financing, research and development, etc. | <ul style="list-style-type: none"> - industry growth has not been as fast or extensive as projected despite government programs to increase sites available for tenure |
| Challenges | <ul style="list-style-type: none"> - intensification and expansion of farming has attracted opposition from local residents and environmental groups due to concerns over environmental and visual impacts - controversy over aboriginal rights resulted in a moratorium on new farms for several years | <ul style="list-style-type: none"> - in some communities, fishers have seen aquaculture as competing with fisheries and therefore have opposed its development | <ul style="list-style-type: none"> - onerous governmental regulations - riparian land owner objections to the expansion of mussel farm sites - lack of integrated coastal planning and urbanizing shorelines have resulted in decreasing water quality in shellfish growing areas | <ul style="list-style-type: none"> - most of the PEI’s usable mussel-growing waters are now being occupied so future expansion will have to be offshore - invasive tunicates lengthen growth cycle - issues with the availability and success of wild mussel seed | <ul style="list-style-type: none"> - lack of intergovernmental coordination - expansion of shellfish farms without adequate local consultation - uncertainty around unresolved First Nations’ claims and their impact on the foreshore and coastal waters |

| Industry characteristic | New Zealand | Spain | Washington State | Prince Edward Island | British Columbia |
|-----------------------------------|---|---|---|--|---|
| Legislation and regulation | <ul style="list-style-type: none"> - various laws apply to aquaculture - under the Aquaculture Reform Act, regional councils are responsible for making decisions about new farm applications using coastal zoning plants | <ul style="list-style-type: none"> - regional authorities are responsible for managing most aspects of shellfish aquaculture - regions create their own regulations for farms - in Galicia, the size and density of mussel rafts is regulated - permits for new leases take 1-2 years | <ul style="list-style-type: none"> - various federal and state laws apply to aquaculture - no single lead agency at the federal level - process for getting approval for new farm sites is complicated, time-consuming and expensive | <ul style="list-style-type: none"> - in PEI, MOU gives DFO responsibility for approving and regulating new farms, perhaps avoiding delays caused by jurisdictional overlap between federal and provincial governments | <ul style="list-style-type: none"> provincial government manages licensing and industry regulations using existing statutes not specific to aquaculture while the federal government addresses protection of wild stocks, navigable waters, and shellfish sanitary regulations |
| Financial support | <ul style="list-style-type: none"> - number of programs in place that offer financial assistance for the development of small and medium-sized enterprises | <ul style="list-style-type: none"> - Spanish government invests funding to support growth and expansion of sector through the Financial Instrument in Support of Fisheries | <ul style="list-style-type: none"> - mussel farmers can access loans and grants through the U.S. Department of Agriculture and through state agencies | <ul style="list-style-type: none"> - farmers can access loans and grants to support start-up costs, production expansion, and development of new technology or products through provincial government | <ul style="list-style-type: none"> - BC Shellfish Aquaculture Working Capital Fund provides loans for new or expanded farms |
| Coordinating bodies | <ul style="list-style-type: none"> - New Zealand Mussel Industry Council Ltd: - funded by a compulsory industry levy | <ul style="list-style-type: none"> - different for each region - e.g. Organizacion de Productores Mejiloneros de Galicia | <ul style="list-style-type: none"> - Pacific Coast Shellfish Growers Association (PCSGA) - funded through member dues | <ul style="list-style-type: none"> - Prince Edward Island Cultured Mussel Growers Association | <ul style="list-style-type: none"> - BC Shellfish Growers Association |

| Industry characteristic | New Zealand | Spain | Washington State | Prince Edward Island | British Columbia |
|--|---|--|--|---|--|
| Technical assistance and technology | <ul style="list-style-type: none"> - National Institute of Water and Atmospheric Research does government-funded aquaculture research - New Zealand Seafood Standards Council - New Zealand Food Safety Authority | <ul style="list-style-type: none"> - AENOR (Spanish Association for Standardization and Certification) sets aquaculture standards | <ul style="list-style-type: none"> - various state and federal agencies provide small business development advice - Washington Office of Shellfish and Water Protection provides shellfish safety certification and growing area classification services | <ul style="list-style-type: none"> - provincial Aquaculture Technology Program provides financial incentives for developing or adopting new technology - provincial Mussel Monitoring Program collects and disseminates technical information directly to growers | <ul style="list-style-type: none"> - provincial Quality Control program addresses the safety and quality of shellfish products through technical work such as water quality sampling and shellfish growing water classification surveys |
| Training and education | <ul style="list-style-type: none"> - consistent, nationally-recognized standards and qualifications for aquaculture training in place - government-funding Seafood Industry Training Organization pays a direct subsidy to businesses for all standards-based training they provide as well as subsidizing training provided through an outside training provider | <ul style="list-style-type: none"> - no general degree in aquaculture is offered by any Spanish university - can take a two-year course and certify as an Operations Technician in Aquatic Cultivation or an Aquatic Production Technician | <ul style="list-style-type: none"> - University of Washington offers a few aquaculture-related biology courses - Peninsula College Center for Aquaculture Training offers workshops that focus mainly on finfish aquaculture | <ul style="list-style-type: none"> - Nova Scotia Agricultural College offers undergraduate and graduate degree programs in aquaculture - two colleges in Nova Scotia and New Brunswick offer one-year courses in practical aspects of aquaculture | <ul style="list-style-type: none"> - Center for Shellfish Research at Vancouver Island University offers support for undergraduate and graduate students interested in research on shellfish aquaculture - Has developed training program including workshops and short courses for First Nations and industry |

| Industry characteristic | New Zealand | Spain | Washington State | Prince Edward Island | British Columbia |
|---|--|---|---|---|---|
| Planning, research, and advocacy | <ul style="list-style-type: none"> - NZMIC is responsible for market promotions, research, environmental issues, public relations and general advocacy for the mussel industry - substantial government investment in aquaculture research | <ul style="list-style-type: none"> - government finances research projects proposed and carried out by individual regions - Spanish Aquaculture Observatory promotes aquaculture research and development and facilitates information exchange between different stakeholders | <ul style="list-style-type: none"> - various state and federal bodies fund and conduct shellfish aquaculture research - Pacific Shellfish Institute develops and disseminates scientific and technical information on shellfish-related environmental and health and safety issues - PCSGA is main advocate for the industry | <ul style="list-style-type: none"> - Prince Edward Island Cultured Mussel Growers Association advocates for the industry and pursues research relevant to its development - Atlantic Canada Aquaculture Industry Research and Development Network provides direction for aquaculture research | <ul style="list-style-type: none"> - BCSGA is main industry advocate. They also help set the direction of industry-relevant research. - provincial government offers funds for aquaculture-related research - provincial government leads coastal planning efforts that impact aquaculture |
| Social enterprises | <ul style="list-style-type: none"> - no specific mention of cooperatives; more may have been present earlier in industry development - NZMIC, as a company operated only to promote industry growth, is in some ways a type of social enterprise | <ul style="list-style-type: none"> - long history of cooperative activity in region - some fishing cooperatives now getting involve in mussel farming | <ul style="list-style-type: none"> - none in Washington but the Kachemak Shellfish Growers Cooperative in Alaska is a marketing and processing cooperative | <ul style="list-style-type: none"> - no specific listings for mussel aquaculture cooperatives - Atlantic Mussel Growers, a company that once acted as the processing and marketing arm for many independent growers, merged with two other companies to form Canadian Mussels Ltd. | <ul style="list-style-type: none"> - the now-defunct Malcolm Island Shellfish Growers Cooperative was working to develop an abalone aquaculture venture |

| Industry characteristic | New Zealand | Spain | Washington State | Prince Edward Island | British Columbia |
|-------------------------------|--|----------------|--|---|---|
| Aboriginal involvement | <ul style="list-style-type: none"> - Maori Commercial Aquaculture Claims Settlement Act (2004) states that 20% of existing aquaculture tenures and 20% of new tenures must be allocated to the Maori - Maori now own whole or part-interests in several large seafood companies that were purchased using money from fisheries claim settlements | Not applicable | <ul style="list-style-type: none"> - focus of western Washington tribes has been more on wild shellfish resources and on beach culture species such as oysters and clams - 2007 settlement provides for shellfish enhancement on public lands and for tribes to acquire more lands for shellfish harvest | <ul style="list-style-type: none"> - no specific examples of aboriginal involvement in mussel aquaculture found - Millbrook First Nation, in Nova Scotia, has built a land-based aquaculture facility for Arctic char | <ul style="list-style-type: none"> - various First Nations groups involved in shellfish aquaculture projects of some sort - most have focussed on oysters, clams or geoducks rather than mussels - about 8% of shellfish aquaculture tenures are farmed by First Nations |

Table 1- Summary of aspects of mussel culture industry development in various jurisdictions

8.0 LESSONS LEARNED

Each of the cases described above provides some important “lessons learned” that are relevant to the development of the mussel culture industry in BC, and to the successful implementation of the Golden Mussel Initiative within an Aboriginal context.

From New Zealand’s experience, we see the important role that industry cooperation played in facilitating the rapid expansion of mussel culture. Producers worked together to establish Greenshell mussels as an internationally-recognized trademark and to develop the frozen half-shell product form used for most of their exports. This coordination seems to have been facilitated by the presence of a strong, mussel-specific industry body with a steady source of funding. This suggests that it is very important that the Golden Mussel enterprises work together to establish the quality and reputation of their brand. New Zealand’s experience with Maori land claims provides a lesson learned for the government of British Columbia. It strongly suggests that issues of aboriginal title have the ability to halt industry growth if they are not addressed. However, the experience of New Zealand’s Maori also provides an example of a situation where there is a strong aboriginal presence in all aspects of the industry, from farming to processing and export.

Spain provides an example of a situation where regional authorities hold the primary responsibility for managing mussel culture. This is similar to the situation in New Zealand once the Aquaculture Reform Act came into effect. Both experiences suggest that this can simplify the regulatory situation that mussel farmers must navigate, reducing their regulatory burden. As well, it limits the possibility of land-use conflicts as these can be directly addressed at the local level. The Spanish mussel culture industry is also an example of an industry with high levels of production where ownership has not become concentrated, but where most producers are still families owning one or two rafts. This has likely increased the importance of producers associations as they can help coordinate the marketing efforts of individual producers. For the Golden Mussel project, the Spanish experience provides evidence of the fact that it is possible to develop a large industry composed of many small producers. This could be particularly relevant to the development of the industry in an Aboriginal context.

In many ways, Washington State provides some examples of what not to do in developing mussel aquaculture. The extremely negative impact that regulatory complexity has had on industry development suggests that streamlining regulation and management is one of the most important things government can do to facilitate industry development. The importance of coordinated coastal planning is also evident in Washington, where the lack of such planning has resulted in conflicts between shellfish aquaculture, land-uses that negatively impact water quality and local land-owners concerned about aesthetic impacts. Again, this suggests that it will be important that the Golden Mussel Initiative takes a pro-active stance to participating in local planning efforts

and resolving possible land-use conflicts before they arise where this is applicable.

From Prince Edward Island's experience, we again see the value of a clear regulatory regime. Furthermore, the importance of coordinated government support to industry development is apparent. The mussel culture industry was able to grow as it did because it had financial and programmatic support from government for research and development of new technologies, technical assistance, and start-up capital. Furthermore, the existence of a mussel-specific producers' association again facilitated the coordinating marketing and branding of mussels produced on the island.

In investigating the current situation in British Columbia, it is clear that not all of the factors that have proved to be important to the growth of mussel culture in other jurisdictions are present. There is currently some industry coordination, but the focus on species other than mussels likely limits the value of this coordination for mussel producers. The regulatory regime is less complex than that in Washington but more complicated than the systems in place in Spain and New Zealand. There is still limited local or regional control over aquaculture planning, leaving mussel culture and other types of shellfish aquaculture vulnerable to land-use conflicts. Finally, current government support for mussel culture development seems somewhat piecemeal. More coordinated support for industry development seems to be needed, including funding for technical research and product development and increased technical assistance and business development support.

Based on the results of the review, it seems that social enterprise has not necessarily been a format commonly used in mussel culture elsewhere. However, there are indications that such an enterprise structure could be very effective in providing the coordination between producers required in order to expand the industry. If the goal is for these social enterprises to continue in this format once the industry has expanded, information from the cases examined suggests that it will be important to devise strategies to avoid the takeover or consolidation of such enterprises into the larger companies that often seem to dominate the industry after expansion.

Results regarding aboriginal involvement with mussel culture suggest that it has not been a primary focus of aboriginal groups in many areas. However, the experiences of the Maori provide an example of aboriginal involvement in all levels of the industry, including in large processing and exporting companies. It is worthwhile to note that in that particular case, access to finances and farm tenures resulting from the settlement of land claims helped facilitate the entry of the Maori into the mussel culture industry at a significant and coordinated level. In fact, significant Maori involvement in mussel culture seems to have occurred mainly after the industry had expanded. In contrast, mussel aquaculture in BC is currently a very small industry so the Golden Mussel Initiative could provide First

Nations with the opportunity to be part of industry development and expansion from the beginning.

9.0 CONCLUSIONS

The following conclusions flow from this BALTA Golden Mussel Project Literature Review: *'Mussel Aquaculture Industry Development Experiences in Different Jurisdictions'*:

1. Industry coordination, comprehensive government support and local-level management are three clear themes that emerge from the case studies explored in this report;
2. They will be important factors to be considered in the design of the enterprises to be developed within an Aboriginal context by the Golden Mussel Initiative;
3. Where the current regulatory and government regime in BC is lacking, it will be important that these enterprises be structured so that they can compensate for these gaps. For example, it will be important to make ample provisions for technical assistance and business development support for the new enterprises as the BC government has limited specific support for shellfish aquaculture businesses in this area;
4. Marketing coordination will be very necessary as the BCSGA currently is not in a position to provide the hands-on coordination that is vital to the development and expansion of mussel culture in the province;
5. The long-term success of the Golden Mussel enterprises will depend on their ability to forestall potential land-use conflicts and negative public opinion regarding environmental impacts by working with government and other stakeholders at a local level to develop the enterprises in a way that benefits all stakeholders; and
6. By learning from the development of mussel culture in other areas, the Golden Mussel Initiative can be a positive force for the expansion and development of mussel culture in BC.

10.0 RECOMMENDATIONS

The conclusions from this review give rise to a number of recommendations for the design of the Golden Mussel industry development system. These recommendations are detailed below:

1. Identifying sources of financial support for communities interested in participating in the GM project and for the development of the industry needs to be a primary consideration during the initial design phase;

2. Given current gaps in technical support available to mussel farmers in BC, internal and external sources of technical assistance should be important components in the design of the GM industry development system;
3. A system for coordinated marketing of GM mussels must be built into the design of the GM enterprises and industry;
4. Effective coordination and cooperation mechanisms that preserve the ability of smaller operators to remain competitive even as industry growth occurs need to be identified and incorporated into the GM industry development system; and
5. Secure sources for Golden Mussel seed stock should be identified and developed as the industry grows.

Other conclusions from this review may be relevant to government, Aboriginal groups or other stakeholders that are interested in facilitating further development of mussel culture in BC. Some potential recommendations for improving the environment and development supports available to the mussel culture industry in BC are detailed below:

1. A better financial support system that provides enhanced access to working capital is needed in order to support industry growth;
2. The development and funding of effective industry coordination bodies should be facilitated. Mandatory industry levies may be one tool for achieving this goal;
3. The technical assistance available to mussel growers should be increased. It should also be provided in a coordinated fashion so that growers do not need to approach three different bodies to access the support they need;
4. A regional-level approach to resolving conflicts over the planning and zoning of areas for shellfish aquaculture should be adopted. All stakeholders should be consulted and involved in developing solutions to tensions between shellfish aquaculture operators and local residents; and
5. A pro-active approach to resolving issues of Aboriginal rights and title claims to foreshore areas should be adopted so that this does not become an issue after industry development has occurred.

References

- AAA. (2007). *Aboriginal aquaculture association*. Retrieved 3/10/2008, 2008, from <http://www.aboriginalaquaculture.com/home.htm>
- ACAIRDN. (2007). *Atlantic Canada Aquaculture Innovation, Research and development network (ACAIRDN) Research Workshop - Final Report*. Halifax. 1-148. Retrieved December 10, 2007 from http://www.dfo-mpo.gc.ca/science/aquaculture/acrdp-pcrda/margulf/tech_reports/MG-07-01-001-T.pdf
- ACOA. (2006a). *Aquaculture industry in Atlantic Canada*. Moncton: Atlantic Canada Opportunities Agency. Retrieved December 29, 2007 from http://www2.acoa-apeca.gc.ca/NR/rdonlyres/30B5A1D3-B64C-41B4-8E71-0B5C09A93C64/0/Aquaculture_EN.pdf
- ACOA. (2006b). *Seafood industry in Atlantic Canada*. Moncton: Atlantic Canada Opportunities Agency. Retrieved December 29, 2007 from http://www2.acoa-apeca.gc.ca.proxy.lib.sfu.ca/NR/rdonlyres/A97E2D2B-150D-4DC9-8933-8E6C0F88F666/0/Seafood_EN.pdf
- ACRDP. (2004). *Mussel seed quality workshop proceedings*. Report MG-03-11-004. *Aquaculture Collaborative Research and Development Program*, Charlottetown. Retrieved January 8, 2008 from http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/science/aquaculture/acrdp-pcrda/margulf/tech_reports/MG-03-11-004-T.pdf

AFL. (2007). *Aotearoa Fisheries Ltd.* Retrieved 3/5/2008 from <http://afl.maori.nz/index.htm>

Albert, B. (2003). Industrial Research Assistance program, National Research Council. Paper presented at the *Workshop - Industry Funding, Interprofessional Organization and Associations Funding, and Research and Monitoring Requirements in Shellfish Aquaculture in New Brunswick*, Miramichi, New Brunswick. 114-131. Retrieved December 28, 2007 from http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/science/aquaculture/acrdp-pcrda/margulf/tech_reports/MG-03-11-001-T.pdf

Atlantic Mussel Growers. (2003). *Company information.* Retrieved August 7, 2007, from <http://www.atlanticmusselgrowers.pe.ca/AboutUs/AboutUs.html>

BC Shellfish Growers Association. (2006). *BC shellfish industry strategic plan* Retrieved November 11, 2007 from <http://bcsga.netfirms.com/wp-content/uploads/2007/07/strategic-plan-june-2006-final.pdf>

BC Shellfish Growers Association. (2007). *Working capital fund.* Retrieved December 3, 2007, from http://bcsga.ca/?page_id=114

Bess, R., & Harte, M. (2000). The role of property rights in the development of New Zealand's seafood industry. *Marine Policy*, 24(4), 331-339.

Bland, V. (2003, November). Designer mussels [Electronic version]. *NZ Business*, Retrieved 2/10/2008 from http://findarticles.com/p/articles/mi_qa5373/is_/ai_n21338919

Blue Seed Project. (n. d.). *OPMEGA*. Retrieved 4/10/2008 from

<http://www.bluseedproject.com/index.php/28/opmega/>

Burrell, M., & Meehan, L. (2006). *The New Zealand aquaculture strategy*. LECG Ltd. Prepared for the New Zealand Aquaculture Council. Retrieved October 20, 2007 from

<http://www.nzmic.co.nz/Assets/Content/Publications/sector%20strategy%20final%20low%20resolution.pdf>

Canadian Mussels Ltd. (2005). *Press release - Canadian Mussels Ltd. enters strategic partnership and distribution agreement with Prins & Dingemans*. Retrieved 10/15/2007, from

<http://www.naia.ca/docs/PressRelease.EUDistribution.Final.pdf>

Canmac Economics, School for Resource and Environmental Studies, Enterprise Management Consultants, & Secretariat of the Atlantic Coastal Zone Information Steering Committee. (2002). *The value of the ocean sector to the economy of Prince Edward Island*. Prepared for the Government of Prince Edward Island. Retrieved December 10, 2007 from

http://www.gov.pe.ca/photos/original/fae_oceans_e.pdf

Cawthron Institute. (2007). *Aquaculture, research and major projects - shellfish, cryopreservation, breeding*. Retrieved 1/24/2008, from

<http://www.cawthron.org.nz/aquaculture/research-major-projects.html>

CBC. (2006). *New tunicate attacking mussel farms*. Retrieved 12/29/2007, from

<http://www.cbc.ca/canada/prince-edward-island/story/2006/09/06/ciona-intestinalis.html>

CSR. (n.d.) *Centre for shellfish research*. Retrieved 12/4/2007, from

<http://www.mala.ca/csr/shellfishtraining/firstnations.asp>

Deal, H. (2005). *Sustainable shellfish: Recommendations for responsible*

aquaculture. Vancouver: David Suzuki Foundation. Retrieved November 8,

2007 from <http://www.davidsuzuki.org/files/Oceans/Shellfish.pdf>

DeJager, T., & Salmon, R. (2006). *Setting priorities for British Columbia shellfish*

aquaculture research and development: Process, outcomes and evaluation.

Nanaimo, BC: Centre for Shellfish Research. Retrieved November 24, 2007

from

http://www.agf.gov.bc.ca/fisheries/reports/WCVI_Shellfish_Development_Report.pdf

Deo, K. (2002). *First Nations and shellfish aquaculture: Consultation,*

accommodation and participation. Victoria: The Environmental Law Centre

Society. Retrieved November 15, 2007, from

<http://www.elc.uvic.ca/projects/2002-03/2002-03-05.pdf>

Department of Natural Resources. (n.d.) *Aquaculture*. Retrieved 1/12/2008, from

http://www.dnr.wa.gov/htdocs/aqr/aquaculture/aqua_leasing.html

Dewey, W., Bunsick, S., Moyer, J., & Plauché, S. (2007). National trends in

shellfish aquaculture production, policy and regulation - planning and

regulatory tools for coastal planners. *Proceedings of Coastal Zone 07,*

Portland, Oregon.

- DFAA. (n.d.) *Aquaculture in New Brunswick*. New Brunswick: Department of Fisheries, Aquaculture, and Agriculture. Retrieved August 10, 2007 from <http://www.gnb.ca/0168/sector2.pdf>
- DFO. (2003). *Blue mussel (mytilus edulis)*. Moncton, New Brunswick: Policy and Economics Branch, Gulf Region. Department of Fisheries and Oceans. Retrieved February 1, 2008 from <http://www.glf.dfo-mpo.gc.ca/pe/profil/mussel-moule/mussel-moule-e.php>
- DFO. (2006). *Aquaculture in eastern Canada - A growing opportunity*. Retrieved 8/25/2007, from http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/aquaculture/multimedia/ppt_200511_e.htm
- DFO. (2007a). *2005 Canadian aquaculture production statistics*. Retrieved 12/14/2007, from http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/communic/statistics/aqua/aqua05_e.htm
- DFO. (2007b). *2006 Canadian aquaculture production statistics*. Retrieved 12/14/2007, from http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/communic/statistics/aqua/aqua06_e.htm
- DFO. (2008). *Aquaculture collaborative research and development program*. Retrieved 1/5/2008, from http://www.dfo-mpo.gc.ca/science/aquaculture/acrdp_e.htm
- DOH. (2007). *Office of Shellfish and Water Protection - Washington State Department of Health*. Retrieved 12/30/2007, 2007, from <http://www.doh.wa.gov/ehp/sf/commercial.htm>

FAO. (2007a). *Mytilus galloprovincialis fact sheet*. Retrieved 12/17/2007, from http://www.fao.org/fi/website/FIRetrieveAction.do?dom=culturespecies&xml=Mytilus_galloprovincialis.xml&lang=en

FAO. (2007b). *National aquaculture legislation overview - New Zealand*. FAO. Retrieved 12/17/2007 from http://www.fao.org/fishery/legalframework/nalo_newzealand

FAO. (2007c). *New Zealand national aquaculture sector overview*. FAO. Retrieved 8/20/2007 from http://www.fao.org/fishery/countrysector/naso_newzealand#tcN70158

FAO. (2007d). *Spain - national aquaculture sector overview*. Retrieved 12/10/2007, from http://www.fao.org/fishery/countrysector/naso_spain

Federation of Maori Authorities. (2007). *Industry profiles*. Retrieved 2/28/2008, from http://www.foma.co.nz/business_info/industry_profiles.htm#aqu

Franco-Leis, M. (2005). Raft culture: Mussel aquaculture in Galicia. Paper presented at the *Second International Mussel Forum*, St John's, Newfoundland. Retrieved November 24, 2007 from <http://www.aquacultureassociation.ca/ac05/abstracts/pdf/Franco2.pdf>

Gagnon, Y. (2003). New Brunswick Innovation Foundation. Paper presented at the *Workshop - Industry Funding, Interprofessional Organization and Associations Funding, and Research and Monitoring Requirements in Shellfish Aquaculture in New Brunswick*, Miramichi, New Brunswick. 75-97. Retrieved December 28, 2007 from <http://www.dfo->

mpo.gc.ca.proxy.lib.sfu.ca/science/aquaculture/acrdp-pcrda/margulf/tech_reports/MG-03-11-001-T.pdf

Gibbs, M. (2006). *The development of fisheries and aquaculture in New Zealand with respect to sustainable development principles* No. 1211. Nelson, New Zealand: Cawthron Institute.

Golden Mussel Group. (2000). *Pacific Golden Mussels*. Retrieved August 20, 2007, from <http://goldenmussels.com/>

Government of Canada. (2007). *Fisheries Act*. Retrieved 1/7/2008, from <http://lois.justice.gc.ca.proxy.lib.sfu.ca/en/F-14/>

Government of New Brunswick. (2007). *Consultation document - aquaculture act and general regulation*. Fredericton: Government of New Brunswick.

Government of PEI. (2008). *Prince Edward Island: Corporate/Business names registry*. Retrieved 1/5/2008, from <http://www.gov.pe.ca/corporations/index.php?txtRegNum=&txtBusName=&drpBusType=8&txtStatus=1&frommonth=01&fromday=1&fromyear=1885&tomonth=12&endday=1&toyear=2008&sortby=1&submitSearch=1&max=100&action=Search>

GSGislason & Associates Ltd. (2004). *A strengths, weaknesses, opportunities & threats (SWOT) assessment of the B.C. seafood sector and tidal water recreational fishing*. Prepared for BC Ministry of Agriculture, Food and Fisheries. Retrieved November 11, 2007 from <http://www.env.gov.bc.ca/omfd/reports/SWOT/index.html>

Hay, B., & Grant, C. (2004). *An introduction to marine resources in Tai Tokerau.*

Auckland: James Henare Maori Research Centre, University of Auckland.

Retrieved January 10, 2008, from

http://www.edesignz.co.nz/hosted/rakiora/IMR_Whangarei.pdf

Hoagland, P., Kite-Powell, H. L., & Jin, D. (2003). *Business planning handbook*

for the ocean aquaculture of Blue Mussels. Woods Hole, Massachusetts:

Woods Hole Oceanographic Institution. Retrieved August 10, 2007 from

<http://www.ooa.unh.edu/annualReports/shellfish/2003/musselBusiness/musselBusinessPlanning.pdf>

Holmes, B. (2003). Shellfish development program, commercial loan program,

business plan, connection program - community business development

corporation. Paper presented at the *Workshop - Industry Funding,*

Interprofessional Organization and Associations Funding, and Research and

Monitoring Requirements in Shellfish Aquaculture in New Brunswick,

Miramichi, New Brunswick. 44-56. Retrieved December 28, 2007 from

http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/science/aquaculture/acrdp-pcrda/margulf/tech_reports/MG-03-11-001-T.pdf

Howlett, M., & Rayner, J. (2004). (Not so) "smart regulation"? Canadian shellfish

aquaculture policy and the evolution of instrument choice for industrial

development. *Marine Policy*, 28(2), 171-184

INAC. (2003). *Aboriginal economic development in Atlantic Canada.* Indian and

Northern Affairs Canada.

Jefferds, I. (2005). Farming mussels - an update of hatchery to harvest in the U.S.A. Paper presented at the *Navigating Forward: New Directions for Food Safety, Quality and Social Diversification. 22nd Annual Meeting of the Aquaculture Association of Canada*, St John's. Retrieved November 24, 2007 from <http://www.aquacultureassociation.ca/ac05/abstracts/pdf/Jefferds.pdf>

Jefferds, A., & Liyanage, S. (2005). *Development of innovation capabilities in the New Zealand seafood industry sector*. Retrieved October 4, 2007, from <http://www.business.auckland.ac.nz/comwebContent/docs/DevInnovationCapabilities.pdf>

Jordana i de Simon, R. (1999). Aquaculture planning and local fisheries: The case of Catalonia, Spain. Paper presented at the *Aquaculture Planning in Mediterranean Countries = Planification De l'Aquaculture Dans Les Pays Méditerranéens. Workshop of the CIHEAM Network on Socio-Economic and Legal Aspects of Aquaculture in the Mediterranean (SELAM)*. Tangiers, Morocco. 43:55-59. Retrieved April 5, 2008 from <http://ressources.ciheam.org/om/pdf/c43/99600255.pdf>

Josupeit, H. (2005). *Mussel production and markets*. Retrieved January 20, 2008 from <http://www.globefish.org/filedownload.php?fileId=244>.

Kachemak Shellfish Growers Co-op. (2006). *Kachemak Shellfish Growers Co-op product page: Alaska oysters and Alaska mussels*. Retrieved 1/10/2008, from <http://alaskaoyster.com/productpage.html>

Kingzett, B., & Norgard, T. (2003). First Nations launch shellfish culture industry in northern British Columbia. *Northern Aquaculture, December*, 6-6.

- Lapointe, C. (2003). Atlantic Canada Opportunities Agency - Business development program. Paper presented at the *Workshop - Industry Funding, Interprofessional Organization and Associations Funding, and Research and Monitoring Requirements in Shellfish Aquaculture in New Brunswick*, Miramichi, New Brunswick. 57-71. Retrieved December 28, 2007 from http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/science/aquaculture/acrdp-pcrda/margulf/tech_reports/MG-03-11-001-T.pdf
- Laszczak, M., Papp, J., Shuman, R., & Sreenath, N. (2004). *Analysis of marine aquaculture policies*. NOAA. Retrieved 1/4/2008 from http://www.lib.noaa.gov/docaquawpiprojects/wpi2004/wpi_rept04-05.htm
- Lummi Nation. (2008). *Natural resources - enhancement*. Retrieved 4/26/2008, from <http://www.lummi-nsn.gov/>
- McCallum, D. E. (2007). BC shellfish aquaculture research and development priorities and issues. Paper presented at the *Atlantic Canada Aquaculture Innovation, Research and Development Network (ACAIRDN) Research Workshop*, Halifax. 138-148. Retrieved December 10, 2007 from http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/science/aquaculture/acrdp-pcrda/margulf/tech_reports/MG-07-01-001-T.pdf
- McClintock, W. L., Baines, J. T., & Taylor, C. N. (2000). Retreat from the frontier: Fishing communities in New Zealand. *8th International Symposium on Society and Resource Management*, Bellingham, Washington.

McVey, E. M. (1991). *Financial sources for aquaculture*. Maryland: Aquaculture Information Network. Retrieved 12/29/2007, from

<http://aquanic.org/publicat/govagen/nal/funding.htm>

MFA. (2006). *Marine Farming Association Inc.* Retrieved 12/14/2007, from

<http://www.nzmfaco.nz>

Ministry of Agriculture and Lands. (2007). *Shellfish development initiative - fisheries and aquaculture - province of British Columbia*. Retrieved 11/20/2007, from

http://www.agf.gov.bc.ca/fisheries/shellfish/shellfish_dev.htm

Ministry of Environment, Oceans and Marine Fisheries Division. (2007). *The 2006 British Columbia seafood industry year in review* Retrieved November 5, 2007 from <http://www.env.gov.bc.ca/omfd/reports/YIR-2006.pdf>

Nazaire, Y. (2003). Business New Brunswick programs. Paper presented at the *Workshop - Industry Funding, Interprofessional Organization and Associations Funding, and Research and Monitoring Requirements in Shellfish Aquaculture in New Brunswick*, Miramichi, New Brunswick. 72-74.

Retrieved December 28, 2007 from http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/science/aquaculture/acrdp-pcrda/margulf/tech_reports/MG-03-11-001-T.pdf

NBDFA. (1999). *Fisheries and aquaculture New Brunswick 98-99 annual report*. Fredericton: Dept of Fisheries and Aquaculture. Retrieved December 10, 2007 from <http://www.gnb.ca/0168/10/ar99.pdf>

New Brunswick Community College. (2008). *Aquaculture technician program*.

Retrieved 1/5/2008, 2008, from

<http://nbcc.ca/viewProgram.asp?id=2149&year=2008&mid=1>

NIWA. (2007). *National Institute of Water and Atmospheric Research - Centre for Fisheries & Aquaculture*. Retrieved 1/10/2008, from

<http://www.niwa.cri.nz/ncfa>

Nova Scotia Agriculture and Fisheries. (2005). *Growing our future - Longterm planning for aquatic farming in Nova Scotia*. Halifax: NSAF. Retrieved

December 10, 2007 from

<http://www.gov.ns.ca/fish/aquaculture/FullReport.pdf>

NSDC. (2005). *Nuu-chal-nulth Seafood Development Corporation – Projects*.

Retrieved 11/7/2007, from <http://www.ncnshellfish.com/projects.shtml>

NWIFC. (2007). *Shellfish settlement*. Retrieved 1/15/2008, from

<http://www.nwifc.org/shellfish/shellfishsettlement.asp>

NZ Seafood Industry Council. (2007a). *Seafood Industry Council - About us*.

Retrieved 1/4/2008, from <http://www.seafood.co.nz/n424,46.html>

NZ Seafood Industry Council. (2007b). *Seafood Industry Council - Greenshell*

mussels. Retrieved 8/20/2007, from <http://www.seafood.co.nz/n361,65.html>

NZ Seafood Industry Council. (2008a). *Exchange rate impact*. Retrieved

1/16/2008, from <http://www.seafood.co.nz/n849,115.html>

NZ Seafood Industry Council. (2008b). *Industry fact file*. Retrieved 1/3/2008, from

<http://www.seafood.co.nz/n403,56.html>

NZFSA. (2007). *New Zealand Food Safety Authority*. Retrieved 1/22/2008, from <http://www.nzfsa.govt.nz/index.htm>

NZMIC. (2008). *New Zealand Mussel Industry Council Ltd*. Retrieved 1/3/2008, from <http://www.nzmic.co.nz>

NZQA. (2008). *New Zealand Qualifications Authority - Aquaculture qualifications and standards*. Retrieved 1/20/2008, from <http://www.nzqa.govt.nz/framework/explore/domain-full.do?frameworkId=75210#nqf-top>

NZSIC. (2007a). *NZ seafood industry council - The commodity levy*. Retrieved 1/4/2008, from <http://www.seafood.co.nz/n296,47.html>

NZSIC. (2007b). *Seafood industry council - industry organisations*. Retrieved 1/3/2008, from <http://www.seafood.co.nz/cso>

NZSIC. (2007c). *Seafood industry council - Science group*. Retrieved 1/4/2008, from <http://www.seafood.co.nz/n430,48.html>

NZSIC. (2007d). *Seafood industry council - Seafood standards council*. Retrieved 1/4/2008, from <http://www.seafood.co.nz/n402,52.html>

OCAD. (2002). *Study no. 4 -Review of provincial and territorial program and services in the aquaculture sector*. Retrieved 11/26/2007, from http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/Aquaculture/ref/Study4_e.htm#4

Olding, T. (2006). *Shellfish aquaculture and the new relationship*. Victoria: The Environmental Law Centre Society. Retrieved October 28, 2007, from, <http://www.elc.uvic.ca/documents/2006-03-02b-shellfish-aquaculture.pdf>

Pacific Aquaculture Caucus. (2007). *About PAC*. Retrieved 1/14/2008, from <http://www.pacaqua.org/about.htm>

Pacific Coast Shellfish Growers Association. (2007). *PCSGA - about us*. Retrieved 9/15/2007, from <http://www.pcsqa.org/about/about.htm>

Pacific Shellfish Institute. (n.d.) *Pacific Shellfish Institute projects*. Retrieved 1/10/2008, from <http://www.pacshell.org/projects.htm>

Pacific Shellfish Institute. (2006). *West coast shellfish research and education 2015 goals and priorities*. Olympia: Pacific Shellfish Institute.

PEIAA. (2006). *The Cultured Mussel Growers Association and cultured mussel industry in Prince Edward Island*. Retrieved 1/4/2008, from <http://www.aquaculturepei.com/organization/mussels.cfm>

PEIAA. (2007). *Prince Edward Island Aquaculture Alliance - Growers*. Retrieved 1/4/2008, from <http://www.aquaculturepei.com/growers/index.cfm>

Peninsula College. (2006). *Welcome to Peninsula College - Aquaculture training*. Retrieved 1/15/2008, from <http://pc.ctc.edu/academics/centers/aquaculture/default.asp>

Porter, A. (2005, January 13). *Mussel-bound: PEI's success yields lessons*. [Electronic version]. *Ellsworth American*, Retrieved January 5, 2008 from <http://www.fobhb.org/library/MusselBound.pdf>

Professional Shellfish Growers Association of New Brunswick. (2003). *Workshop - industry funding, interprofessional organization and associations funding, and research and monitoring requirements in shellfish aquaculture in New*

Brunswick. Paper presented at the *Final Report*, Miramichi, New Brunswick.

1-340. Retrieved August 28, 2007, from http://www.dfo-mpo.gc.ca/science/aquaculture/acrdp-pcrda/margulf/tech_reports/MG-03-11-001-T.pdf

Regulatory and Federal Assistance Division. (n.d.) *Catalogue of federal domestic assistance - 10.407 FARM OWNERSHIP LOANS*. Retrieved 1/23/2008, 2008, from http://12.46.245.173/pls/portal30/CATALOG.PROGRAM_TEXT_RPT.SHOW?p_arg_names=prog_nbr&p_arg_values=10.407

Restakis, J. (2006). *Defining the social economy – The BC context*. Prepared for the BC Social Economy Roundtable. Vancouver: BC Cooperative Association.

Rollins, R., & McCallum, D. E. (2005). Strategies for use and perception of the marine environment: Perceptions of acceptability of shellfish aquaculture in Parks Canada's proposed southern Strait of Georgia National Marine Conservation Area (NMCA).

Paper presented at the *Coastal Zone Management & Shellfish Aquaculture in BC: A Forum on Current Research and Emerging Policy Priorities*, Nanaimo, B.C. Retrieved November 10, 2007, from, http://web.mala.bc.ca/aquanet/PPTs/Detailed%20Report%20PPT_Residents'%20Survey.ppt

- SABRI. (2007a, April). Mussel farming. *Tides: The newsletter of St. Anthony Basin Resources Inc.*, 1.
- SABRI. (2007b). *St Anthony Basin Resources Inc. - Mussel farming*. Retrieved 01/04/2008, from http://www.sabrinl.com/mussel_farming.html
- Sanchez-Mata, A., & Mora, J. (2000). A review of marine aquaculture in Spain: Production, regulations and environmental monitoring. *Journal of Applied Ichthyology*, 16(4), 209-213. \
- Seafood Innovations. (2007). *Seafood Innovations Ltd - About us*. Retrieved 12/14/2007, from <http://www.seafoodinnovations.co.nz/si-about>
- SITO. (2007a). *Seafood Industry Training Organization*. Retrieved 10/10/2007, from <http://www.sito.co.nz/n750.html>
- SITO. (2007b). *Training providers directory for the seafood industry*. Wellington: Seafood Industry Training Organisation. Retrieved December 10, 2007 from http://www.sito.co.nz/f834,45724/45724_TP_Dir_2007.pdf
- Tollefson, C., & Scott, R. (2006). Charting a course: Shellfish aquaculture and indigenous rights in New Zealand and British Columbia. *BC Studies*, 150, 3-43.
- University of Washington. (2007). *College of Ocean and Fishery Sciences courses*. Retrieved 1/6/2008, from <http://www.washington.edu/students/crscat/fish.html>
- USDA. (2006). *Census of aquaculture 2005*. No. AC-02-SP-2 United States Department of Agriculture. Retrieved November 24, 2007 from

<http://www.agcensus.usda.gov/Publications/2002/Aquaculture/AQUACEN.pdf>

[f](#)

USDA. (2007a). *Business and industry guaranteed loans*. Retrieved 1/20/2008, from http://www.rurdev.usda.gov/rbs/busp/b&i_gar.htm

USDA. (2007b). *FSA - farm loan programs*. Retrieved 1/23/2008, from <http://www.fsa.usda.gov/FSA/webapp?area=home&subject=fmlp&topic=landi>
[ng](#)

USDA. (2007c). *Value-added producer grants*. Retrieved 1/14/2008, from <http://www.rurdev.usda.gov/rbs/coops/vadg.htm>

USDA. (2008). *Program synopsis: Small business innovation research (SBIR) program*. Retrieved 1/20/2008, from http://www.csrees.usda.gov/funding/sbir/sbir_synopsis.html

Warris, P. (2007). R and D priorities for the PEI aquaculture industry. Paper presented at the *Atlantic Canada Aquaculture Innovation, Research and Development Network (ACAIRDN) Research Workshop*, Halifax. 100-125. Retrieved December 10, 2007 from http://www.dfo-mpo.gc.ca.proxy.lib.sfu.ca/science/aquaculture/acrdp-pcrda/margulf/tech_reports/MG-07-01-001-T.pdf

Washington Sea Grant. (2007). *Shellfish aquaculture*. Retrieved 12/12/2007, from <http://www.wsg.washington.edu/mas/resources/shellfish.html>

- Washington State. (2007). *International trade and economic development - Business loans*. Retrieved 1/20/2008, from http://www.choosewashington.com/business_resources/Financing.asp
- WDFW. (2007). *Washington Department of Fish and Wildlife - Fish & shellfish science*. Retrieved 1/5/2008, from <http://www.wdfw.wa.gov/fish/management/index.html>
- Whakatohea Maori Trust Board. (2005). *WMTB mussel farms*. Retrieved 12/20/2007, from <http://www.whakatohea.co.nz/prod01.htm>
- WRAC. (2005). *Western Regional Aquaculture Center*. Retrieved 12/16/2007, from <http://www.fish.washington.edu/wrac/history.html>
- WWF. (2007a). *Mollusc aquaculture dialogue*. Retrieved 12/14/2007, from <http://www.worldwildlife.org/cci/dialogues/mollusc.cfm>
- WWF. (2007b). *Mollusc industry representatives move forward with aquaculture certification*. Retrieved 12/14/2007, from <http://www.worldwildlife.org/news/displayPR.cfm?prID=447>