Fisheries and Oceans Canada | Pêches et Océans Canada

Profile of the Blue Mussel (*Mytilus edulis*)

Gulf Region

Policy and Economics Branch, Gulf Region
Department of Fisheries and Oceans
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Canada

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Glossary

Approved area (uncontaminated area): The classification of a shellfish growing area which has been approved through a sanitary survey of the water by the shellfish control authority for growing or harvesting shellfish for direct marketing. The sanitary survey of this area indicates that even under adverse conditions, wastewater effluent from neighbouring areas does not represent a risk to public health. (In those areas, the median or geometric mean faecal coliform Most Probable Number (MPN) of the water does not exceed 14/100 mL, and not more than 10% of the samples exceed a faecal coliform MPN of 43/100 mL.)

Aquaculturists (oyster growers or producers): holders of shellfish leases in the provinces of New Brunswick, Nova Scotia or Prince Edward Island, who grow their own mussels from spat/seed.

Conditionally approved area: The classification of a shellfish growing area determined by the shellfish control authority to be conditionally approved. This area has the same sanitary quality as approved areas, however, the quality varies with (A) the effectiveness of sewage treatment at a community, (B) Rainfall or river flow, (C) Seasonal changes in sanitary conditions (i.e. tourist or summer cottage activity, vessel traffic, seasonal industrial operation). The area has to meet approved area criteria for a predictable period, which the period is conditional upon meeting established performance standards specified in a memorandum of understanding signed by the parties concerned.

Closed area (contaminated area): A bivalve shellfish growing area where the harvesting of shellfish is temporarily or permanently prohibited due to water contamination, except by special licence for specific purposes such as depuration, relaying, and experimental purposes.

Coastal fisher: A fisher, who is not a core fisher (see definition) and who holds at least one key commercial non-vessel based licence. Key commercial non-vessel based licences for the three Administrative Areas of the Gulf Region are as follows:

- Prince Edward Island: Clams, eel, marine plants, oysters, and smelt;
- Eastern New Brunswick: Clams, eel, gaspereau, oysters, and smelt;
- Gulf Nova Scotia: Clams, eel, gaspereau, oysters, and smelt.

Commercial fishing licence: A fishing licence is a document by which the Minister of Fisheries and Oceans, pursuant to his discretionary authority under the *Fisheries Act,* grants permission to a person including an Aboriginal organization to harvest certain species of fish or marine plants subject to the conditions attached to the licence.

Core fisher: Registered licenced fisher who participates in fisheries where vessels less than 19.8m (65') in length are used. To qualify as member of the core group, a licence holder is required to meet the following four criteria as of December 20, 1995: 1) Be the head of a fishing enterprise; 2) hold key licence (snow crab, lobster "A", groundfish (but not handline), scallop, tuna or herring); 3) have an attachment to the fishery; 4) be dependent on the fishery.

Depuration (or controlled purification): The process of using a controlled, aquatic environment to reduce the level of pathogenic (unwanted) bacteria and viruses in live shellfish.

Integrated Fisheries Management Plans: Plans that are designed to outline the conservation regarding the sustainable use of fisheries resources. They are based on scientific knowledge, as well as conservation and protection measures and integrate the various DFO sectors, as well as encourage input by all stakeholders. These Integrated fisheries management plans give rise to co-management which ensure transparency, establish all allocations between sectors and fleets, provide relevant information in context, and ensure that clients and stakeholders are consulted on the comprehensive strategies and objectives for management of each fishery.

Lease: The precise definition of the term lease may vary somewhat between provinces. In general however, a lease usually ensures the right to exclusive use of a property for a period of time and for a specified specie and give the leasee exclusive rights to the cultured specie.

Seed (mussel): Any small size mussels (usually around 15-mm).

Spat (mussel): Last larvae stage, the veliger larvae.

Statistical district or area: A geographical division of the managed area (see Appendix 3 for list of statistical districts).

Value at landing: Cash value of the harvested fish species recorded upon landing (i.e. the quantity of marketable mussels landed multiplied by the price per unit measure or the value indicated by the buyer).

Executive Summary

The Blue mussel is the most important molluscs cultivated in the Gulf Region. The purpose of this profile is to provide an overview of the Blue mussel's (*Mytilus edulis*) wild fishery and aquaculture activities presently in place in the Gulf Region.

Chapter One describes the habitat and general biology of the *M. edulis*, which is a specie of shellfish scientifically classified as a bivalve mollusc. Blue mussels are found in the rocky shores along the coastlines, bays, and river mouths, where the mussels attach themselves to submerged surfaces. In the Gulf Region, mussels generally become sexually mature in late spring and spawning usually occurs between May and August. They feed mainly on phytoplankton. Predators, parasites, diseases, and adverse environmental conditions have been known to cause mussel mortality. Also, the consumption of mussels that ingested biotoxins such as domoic acid can lead to illness and sometimes death in humans and other mussel predators.

Chapter Two describes the principal methods of collecting growing mussels. In the Gulf Region, the majority of mussels are grown on the suspended longline system. Growers can obtain mussel seed by collecting it on their site or buying it from commercial fishers. The mussel seed are loaded into socks that are suspended on the longlines where they will grow to commercial size mussels (around 50-mm) in 18-24 months.

Chapter Three lists the authorities responsible for the management of the commercial mussel fishery and of aquaculture and describes the principal mussel management measures in place in the Gulf Region, such as seasons, licencing and leasing. At present, there are about 335 issued mussel leases covering 5,384 hectares, of which 84% is located in PEI where the depth and quality of water, as well as shelter, is so adequate for growing mussels.

Chapter Four highlights data on employment, production, and markets and provides some statistical analysis of the mussel culture and fishery. In addition to the 922 commercial mussel fishers, there are close to 1,500 people working on mussel aquaculture operations and in processing plants. Records indicate that there were over 18, 000 metric tons of cultivated mussels, valued at over $24 Million in 2001, which is more than four times the amount of 1992. Prince Edward Island is the leading mussel producer in the country, accounting for close to 96% of the Gulf Region's production and 81% of Canada's production. The majority of mussels are sold fresh to large Canadian urban centres, although in the last five years, exports going principally to the United States have been increasingly contributing to the Gulf Region economy.

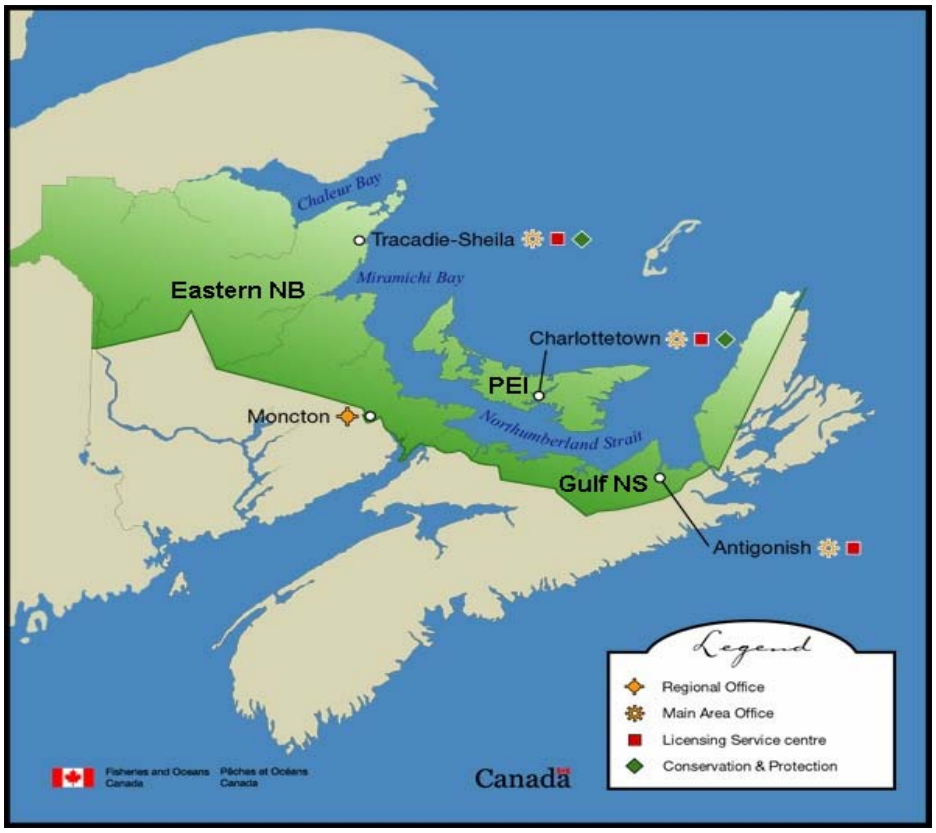
Chapter Five lists some of the Gulf Region's aquaculture and bivalve shellfish research and education programs, as well as some facilities supporting their development.

Finally, a conclusion finishes the profile.

Introduction

The following profile provides an overview of the Blue Mussel aquaculture and wild fishery activities occurring in the Gulf Region (Figure 1). The Department of Fisheries and Oceans Canada (DFO) gave the Gulf Region the responsibility to manage the distinct entity of the southern Gulf of St.Lawrence. The Region comprises all the waters of the Gulf adjacent to the eastern coast of New Brunswick (Eastern NB), the Northumberland Strait coast of Nova Scotia (NS) and western Cape Breton Island known as Gulf NS, as well as the whole of Prince Edward Island (PEI).

Figure 1. Gulf Region Management Areas (in dark)



In 1995, Cabinet endorsed the *Federal Aquaculture Development Strategy* (FADS), invigorating the federal government's commitment to aquaculture development and affirming the role of DFO as the lead federal agency in this regard. The definition adopted in the FADS is the one prompted by the United Nations Food and Agriculture Organization (FAO), which is:

> "*Aquaculture is the culture of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Culture implies some form of human intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Culture also implies individual or corporate ownership of the stock being cultivated.*"

Chapter 1 – General Characteristics of the Blue mussel

1.1 Habitat

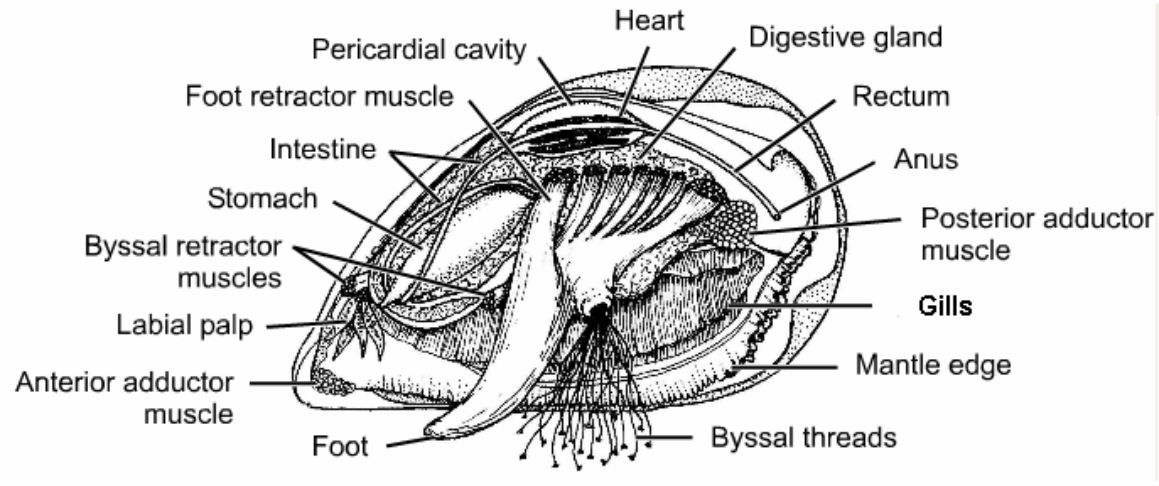
The *M. edulis* are found worldwide in most polar and temperate waters. In North America, mussels are circumpolar in distribution extending south in the western Atlantic Ocean to South Carolina. They may be found in habitats ranging from slightly brackish shallow estuaries to highly saline deep offshore environments, but tend to occur in bays and estuaries that have elevated levels of nutrients from land runoff, causing an increase in phytoplankton. In the Gulf Region, mussels are found in the rocky shores along the coastlines, bays, and river mouths, where the mussels attach themselves to submerged surfaces.

1.2 Biology

Figure 2. Mussel Meat and Shells

The two shells of the mature mussels are smooth, identical, and somewhat pear-shaped (Figure 2). Projecting out from between the shells on one side is a bundle of tough, brown fibers called the byssal threads or byssus, more commonly known as the "beard". The outside of the shell is usually glossy bluish or bluish black, but sometimes pale brown and rayed and the inside is generally violet in color. Inside the shells the meat (soft tissue) of the mussel is usually pink to orange (female) or cream colored (male). In the Gulf Region the meat of the mussels is of optimum quality for consumption around March, April, May, October and November when they are not in post-spawning condition, usually when the water temperature is colder than in Summer.

Figure 3. Major internal anatomical features of a mussel



Source: © BIODIDAC

1.2.1 Reproduction and Early Development

Sexes are usually separate (dioecious), but some individual with both sexes (hermaphrodites) may occur in the population. Mussels generally become sexually mature in late spring or early summer, the formation of sperm or eggs (gametogenesis) occurring in numerous ducts located principally in the mantle (Figure 3). Spawning generally occurs in the Gulf Region sometime between May and August, usually in response to environmental triggers such as high food levels, temperature fluctuations, and physical disturbance. Following spawning, mussels release some or all of their eggs or sperm in the water and whitish or orange clouds can be seen. Fertilization occurs in the water column and in a very short time the embryos differentiate into free-swimming larvae.

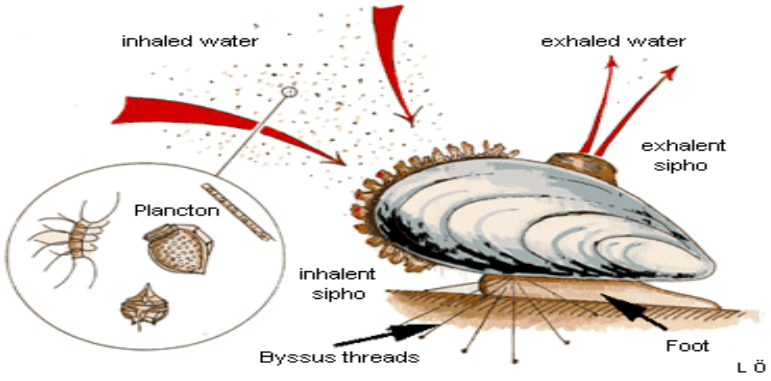
It only takes five hours for the embryo to begin to swim, feeding on small phytoplankton cells and growing to the last larvae stage, the veliger larvae, often refer to as spat. Larvae are free swimming for 3 to 4 weeks until the final metamorphosis when they seek to settle. At metamorphosis, the mussel extends the foot, withdraws the vellum, and secrets byssal threads to initially fasten themselves to solid substrate such as collectors, wharf-pilings, filamentous algae, or rocks. This occurrence is generally referred to as mussel spatfall which occurs around mid-June to late-July. The mussel is now referred to as juvenile mussels and they can easily detach themselves and change locations, either by using their foot to actively crawl or by floating passively in the water column. If stressed, the mussel can therefore continuously reattach itself to another substrate until it settles permanently. However, movement becomes increasingly limited as it become heavier and when it finally anchors on a suitable hard substrate, it will grow into a mature mussel.

1.2.2 Growth and Feeding Habits

Once permanently set, the competition for space is vigorous. It is common to find mussels growing in layers of other mussels, both naturally in intertidal and sub-littoral levels, and when cultured on lines. The mussels have the ability to grow under a broad range of environmental conditions. They can tolerate a wide range of salinity - between 0ppt to 31ppt - the optimum being around 26ppt. It seems that lower intertidal individuals have more rapid growth than higher intertidal ones because mussels grow most quickly when continually immersed in water where they can almost constantly feed. In and around the Gulf Region, mussels also withstand a wide range of temperatures – between sub-zero to 25°C. Although the growth rate of mussels is reduced at low temperatures, they can tolerate below zero temperatures and significant growth may still occur in cold waters (between November and April) where food availability is high.

Mussels are suspension feeders and compared to other molluscs, they are the most efficient feeders. They feed by actively filtering particles from the water, which passes into and out of the mantle cavity through the frilled siphons (or sipho) (Figure 4). Breathing also occurs as this stream of water passes over the creature's gill. Phytoplankton cells both living and dead, constitute the main source of food, but other sources of carbon such as decomposed macrophytes or resuspended detritus may also supplement their diet. As stocking density increases, the demand for food eventually exceeds the supply, ultimately resulting in food limitation, which in turn could reduce growth.

Figure 4. Mussel Respiration



Source: Aquascope, 2000.

In summary, time for development to the mature adult stage depends ultimately on various location specific factors. In general however, mussels in the Gulf Region take 18-24 months to grow to about the 50 mm-commercial size, pumping around 4 litres of water an hour.

1.2.3 Mortality

Different agents such as predators, parasites, diseases, or even environmental conditions may cause mussel mortality. Summer mussel mortality is more frequent

because of high water temperature levels in conjunction with low food levels. As larvae, mussels are preyed on by zooplankton and small fishes. As juvenile and adult, they are preyed on mainly by sea ducks, starfish, crabs, and of course, humans.

Recently, other aquatic invaders in the Gulf Region have become serious pests for mussels. The oyster thief (*Codium fragile tomentosoides*), a green alga native of Japan detected in 1996 at Caribou, NS, smothers mussels and oysters, preventing them from opening their shells to filter feed. Starved and weakened mussels are then easy targets for predators.

The clubbed tunicate (*Styela clava*) is native from the western Pacific and was reported in the Brudenell River, PEI, in January 1998. Clubbed tunicates grow in dense clump, interfering with the settlement of larvae and competing against young mussels for space and food.

1.2.4 Mussel-Associated Illness

Certain species of natural occurring microscopic algae that bloom under favourable hydrographic conditions can produce biotoxins, such as domoic acid. Filter-feeding molluscs such as mussels accumulate the toxins when utilizing toxic algae as a food source. The consumption of toxic mussels by human and even by predators can lead to illness and sometimes death. The toxins do not kill the mussels nor cause any discernible changes in appearance, smell, or taste that would alert mussel consumers of toxicity. As hydrographic conditions become less favourable, the bloom subsides and with time, the mussels rid themselves of the toxins and are once again safe to eat. The rates at which toxins are accumulated and eliminated vary between species. However, experiments on the pumping rates of bivalve molluscs indicate that mussels are the most efficient filter feeders thus exposing them to more risk of biotoxin accumulation.

There are several types of illnesses caused by marine biotoxins that are connected with the consumption of contaminated bivalve shellfish. They include Paralytic Shellfish Poisoning (PSP), Amnesic Shellfish Poisoning (ASP), and Diarrhetic Shellfish Poisoning (DSP). The toxins are named for the most notable symptom they cause, i.e., paralysis, amnesia and diarrhea, respectively.

Pursuant to an international agreement signed in 1948, Canada has implemented the *Canadian Shellfish Sanitation Program* (CSSP), which is jointly administered by DFO, the Canadian Food Inspection Agency (CFIA) and Environment Canada. The CSSP has the primary objective to protect the public from the consumption of contaminated shellfish by ensuring that bivalve shellfish are harvested from waters of acceptable sanitary quality. The classification of bivalve shellfish growing waters is based on the sanitary and bacteriological water quality conditions of the area and the classifications used are approved, conditionally approved, and closed areas.

Chapter 2 – Mussel Harvesting Methods

During the Second World War, wild mussels were canned and harvested in PEI, but only in small quantities because they were heavily filed with pearls and had poor market value. In the 1970's, a system for growing mussels on suspended longlines was developed. Commercial growers began to use this technology in 1981. Still today in the Gulf Region, few wild mussels are marketed to the public, as their meats are much smaller and tend to contain a lot of pearls. However, there are numerous sheltered bays and inlets highly suitable for growing mussel and *M. edulis* is presently the most important bivalve molluscs being cultured in the Gulf of St. Lawrence.

2.1 Wild Commercial Fishing Methods

The *Maritime Provinces Fishery Regulations* stipulate that you can only fish for mussels by hand, with hand-held tools (i.e. rake, pitchfork, tong and shovel) with a drag rake, hydraulic device or mechanical device or by diving. In the Gulf Region, there is no legal minimum size for mussel and wild mussel harvesting is almost always for gathering small mussels. The small mussels can be forked or shoveled into fish trays from the shoreline at low tide where they are transported by truck or small boats to a mussel lease where they are normally sold or used as seed by the mussel grower.

2.2 Methods of Culture

The selection of a grow-out site that will produce quality market-sized mussels within an acceptable time frame is crucial for the profitability of a mussel culture operation. The ability to select the best site will depend on the understanding of specific local environmental factors that influence production levels, such as site exposure, temperature, current velocity, sediment loading, and food availability, as well as on the understanding of specific regional environmental factors, such as tidal amplitude, ice coverage, seasonal weather patterns, and climate.

Around the world, some mussels are grown in bottom culture systems, but many places grow them in suspension (off-bottom systems) because suspended culture from rafts or longlines has proven to yield the greatest production per unit area. In the Gulf Region, virtually all mussels are grown in suspension and the longline system specifically, is generally used. This profile will therefore focus on off-bottom methods of culture and some of its benefits.

2.2.1 Off-Bottom

Many mussel aquaculturists in the Gulf Region choose the fully suspended method because their experience has shown that mussels that do not touch the bottom do not

have the opportunity to pick up grit or form pearls. (Although this is true for the first two years of growth, aquaculturists have experienced mussels that grow pearls if kept in suspension longer than 24 months). Another reason for choosing the suspended method of culture is that mussels are distributed evenly in a control setting where they have equal access to nutrition and therefore, they are more likely to have an even growth rate with high meat to shell ratio. In fact, growers in the Gulf Region have shown that their cultured mussel deliver twice as many mussel per pound, as well as meat yields that are usually 3 to 4 times higher than wild.

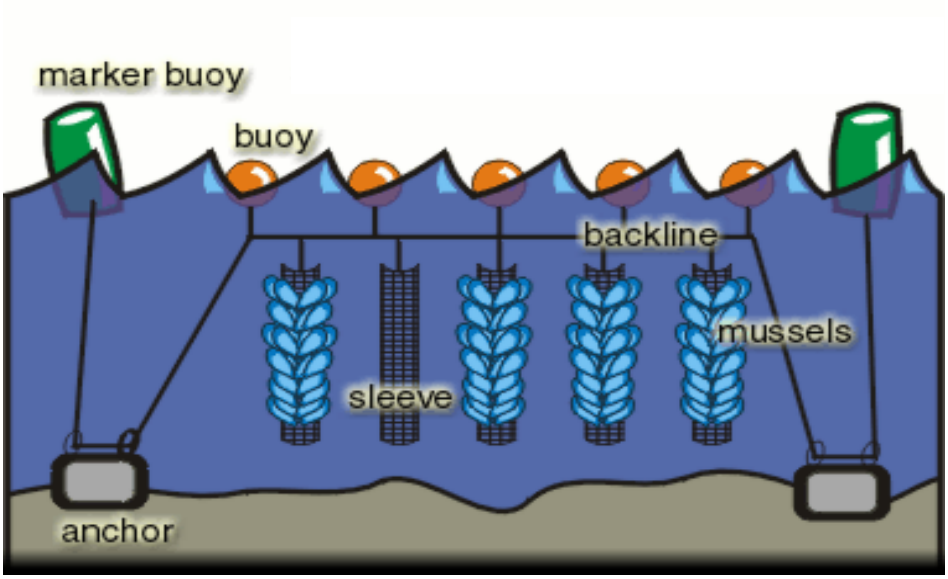
2.2.1 a) Longline system

The longline system consists of the backline (headrope), sleeves (or socks), buoys, anchors and anchor rodes (Figure 5). The seed collectors or plastic mesh socks are attached to the backline (headrope). Most longline operations use long polypropylene ropes (80-150 m) that are anchored securely at both ends and are supported by floats tied at intervals along their length.

Floatation devices represent a major cost of the mussel operation. Although producers will often use more expensive buoys with longer life expectancy and greater buoyancy, which may translate into a better investment over time, the most common floatation device is the standard styrofoam lobster buoy coated with paint.

There are many different types of anchors, and the anchoring system choosen will depend on cost, bottom type, current, ice and other local factors. One common anchoring system that is found in the Gulf Region are steel barrels cut in half and filled with concrete put at the end of each line. Some growers, because of its lower costs and more secure attachment, also favour the "monoblock" type of anchors, which consists of railroad tracks anchoring three to five longlines side by side.

Figure 5. Long-line system



Source: The Fisheries Then & Now.

2.2.1 b) Seed collectors

To be able to grow mussel you first need to obtain seed and aquaculturists require huge quantities of seed to ensure a good crop. That is one reason growers will have seed and larger mussels growing at the same time. Unpredictable and insufficient seed supply due to poor recruitment can become a constraint to the expansion of the mussel operation. The selection of a site for the collection of seed is therefore as important to the identification of a grow-out site. The recruitment success at a particular site is dependent on various factors, such as duration and timing of the settlement period, the number of viable larvae produced, retention of larvae within the system, mortality, and predation.

Although a small proportion of growers (i.e. around 5% in PEI) buy seed from fishers, growers depend on this source of seed. Many growers also opt to obtain a licence to collect their own seed on their lease. They can attach the seed collectors to the backline, which usually gives a relatively uniform size distribution of seed. The collectors can be made from all sorts of materials such as old rope, Italian socking material, nylon bags, and vexar mesh. Also, there are reports indicated that a newer fuzz rope or artificial seaweed, which has been on the market for about seven years, greatly enhanced seed collection. Whatever the material used, the collectors are usually hung on the lines just before the spat are expected to settle in the summer.

2.2.1 c) Socks

Mussel spat will grow on the collectors until it reaches a seed-size of about 15 mm, usually by fall when the mussel seeds are stripped off the collectors so they can be declumped and graded to remove those that are too small (usually less than 4 mm). The seeds are then transferred to grow-out units where the mussels are loaded into socks.

After socking, the mussels are sometimes bathed in seawater for some twelve hours to allow the formation of byssal threads, before suspending them from the longlines where they grow to market size. The average mussel sock will hold between 15 and 30 kilograms of mussels once they reached commercial-size (Figure 6).

Figure 6. Mussel Socks

Source: NB Images (Government of New Brunswick)

Once the cultured mussels have reach market size (between 55-60 mm), which can take from 18 to 24 months, harvesting is carried out on special vessels that have equipment such as a boom and a manual or hydraulic winch system that lift the long lines from the water. The socks can then be detached and transferred in the fishing boat or small barge. To minimise the losses of mussels during this transfer, the vessel may have a chute to guide the longline and socks aboard or sometimes a basket is place below the sock to recover any fallen clumps. The cultured mussels are then stripped from the socks and transferred to plastic boxes, which are iced during the warmer months.

2.2.1 d) Winter harvesting

During the winter months, the ice presence impose a specific harvesting technique that can be more or less specialised depending on the importance of the operation. The first step is to be able to identify with precision the location of the mussel long-line system, which is easily done with the Global Positioning System (GPS). The employees will get to the location using snowmobiles, all terrain vehicles, trucks, or slays, depending on ice conditions, and they will drill holes in the ice, generally with a hydraulic saw. The long-line system is then hauled out of the water with a hydraulic system attached to an A-frame, and the socks are recuperated and put in isotherm boxes.

Chapter 3 – Mussel Harvesting Management

3.1 Management Strategy

3.1.1 Wild Mussel Fishery

In the Gulf Region, multi-year Integrated Fishery Management Plans in conjunction with annual mussel harvesting plans are developed by the Department of Fisheries and Oceans (DFO) who is responsible for managing the wild mussel fishery. The Department develops these plans in consultation with its clients (commercial fishers, Provincial fisheries, members of the Aboriginal communities, producers, processors, etc.). The wild commercial mussel fishery in approved areas (uncontaminated waters) are for the most part managed based on effort controls, the most significant of which are fishing seasons, gear types and area closures.

In addition to effort controls, there are also output controls for some fisheries:

- Licensed fishers participating in the contaminated mussel spat collection are limited to a maximum of 150 trays of mussels.
- A 10,000 lbs. quota for bivalve molluscs that includes mussels was issued in 2001 to Lennox Island (PEI) and a combined total of 4,000 lbs. for mussels and clams was issued to Indian Island (NB) for food, social and ceremonial purposes.

Following are key legislation for the management of the wild mussel fishery:

- Fisheries Act;
- Fishery (General) Regulations;
- Maritime Provinces Fishery Regulations;
- Management of Contaminated Fisheries Regulations; and
- Aboriginal Communal Fishing Licences Regulations.

Fishing activities are controlled and monitored by the Conservation and Protection branch who is responsible for patrolling areas where mussels are harvested.

3.1.2 Cultured Mussels

DFO is also the lead federal agency for aquaculture development and is committed to ensuring the responsible and sustainable development of the aquaculture industry in Canada. The Department is responsible to enforce regulations governing aquaculture activities, such as patrolling and controlling leased areas to ensure that the leases are properly marked and that mussels are grown and harvested with-in the defined area. In Prince Edward Island, DFO is responsible for the administration of aquaculture leases since 1928 when an agreement was signed between the Dominion of Canada and

PEI, which was reconfirmed between the Government of Canada and PEI in the 1987's Agreement for Commercial Aquaculture Development.

New Brunswick passed an aquaculture act in 1988 and signed a Memorandum of understanding (MOU) with DFO in 1989, which affirmed that the New Brunswick Department of Agriculture, Fisheries and Aquaculture (DAFA) is now responsible for the administration of aquaculture licences and leases.

Nova Scotia was the first province to pass an aquaculture act, establish regulations, and appoint a provincial aquaculture coordinator. The Province also signed a MOU with DFO affirming that the administration of aquaculture licences and leases in Nova Scotia is the responsibility of the Nova Scotia Department of Agriculture and Fisheries (DAF).

3.2 Seasons

3.2.1 Wild Mussel Fishery

Although wild mussels can be fished throughout the year in approved areas, the heaviest fishing effort occurs during Spring and Fall. The Aboriginal commercial communal fishery is usually open from May to December.

The season for wild commercial mussel fishery in contaminated areas is shorter than in approve areas; it is usually open from May to mid-July.

There is also a recreational fishery, which is open year-round, although there are very few participants.

3.2.2 Cultured Mussels

There is no defined season for harvesting mussels on leases and aquaculturist from different regions may vary somewhat in the timing of their annual production cycle. In the Gulf Region however, the heaviest concentration of harvesting usually occur between October and June so the aquaculturists can aim at marketing their mussels before warmer months in order to minimize the risk of summer mortality.

3.3 Licences and Leases

3.3.1 Wild Commercial Fishing Licences

A licence is required to harvest wild mussels commercially. New entry for mussel licences to fish by hand or with hand-held tools wild seed or mature mussels are issued

by DFO and available to core and coastal fishers. All individuals participating in the commercial mussel fishery in the Gulf Region must be registered as a commercial fisher and mussel licences must be renewed on an annual basis. Moreover, a fisher must hold a mussel licence in approved area (clean waters) in order to be issued one for mussel seed in approved contaminated areas. There is no licence required for the mussel recreational fishery, which allows harvesting solely for pleasure and personal use.

3.3.1. a) Distribution of licences

In general, commercial mussel fishing licences issued in the Gulf Region is for fishing in clean waters (approved areas) and in PEI, most commercial mussel licences is for gathering small mussels that will be sold as seed to growers. Moreover, in the last three years because of a shortage of seed, PEI has been issuing a Spring licence to commercial fishers for collecting seed mussels in approved contaminated areas. Nineteen of these licences were issued in 2002, which represent 2.6% of PEI's commercial mussel licences. In the Gulf Region, around 75% of all commercial mussel licences are issued in PEI, 24% in Eastern NB, and 1% in Gulf NS.

In addition, there are a few communal commercial mussel licences issued to First Nations/Council. One such licence has been issued to Abegweit First Nation (PEI), six to Lennox Island First Nation (PEI) and eight to the National Council of PEI. Table 1 shows the breakdown of Gulf Region's mussel licences by area.

Table 1. Mussel Licences Issued by Area, Gulf Region – 2002

LICENCE	PEI	Eastern NB	Gulf NS	TOTAL GULF
Commercial (including Spring seed licences)	708	224	9	**941**
Aboriginal Communal Commercial Fishery	15	0	0	**15**
TOTAL	**723**	**224**	**9**	**956**

3.3.2 Lease Application Process

The application processes for PEI, NB, and NS (illustrated below) are similar, except that the lead agencies are different. The complexity of the application will determine the turnaround time to process it. Most mussel lease applications will require a formal assessment under the *Navigable Waters Protection Act* (*NWPA*) and under the *Canadian Environmental Assessment Act* (*CEAA*), which will require additional time for review.

Application Process for a New Marine Aquaculture Site

Step 1	• The DFO Charlottetown Aquaculture Division in **PEI**, • the New Brunswick DAFA in **NB**, or • the Nova Scotia DAF in **NS**	is responsible for helping the applicant complete and submit a **lease application package**, which includes an application fee, an application form, a site development plan, and a digital map showing the site location.
Step 2	• The Leasing Referral Committee[1] in **PEI**, • the New Brunswick DAFA regional office in **NB**, or • the Technical/financial Committees[2] in **NS**	will evaluate the applications, *review issues against current policy, coordinate the *NWPA* and *CEAA* review, coordinate public notifications and consultations, develop recommendations, and provide advice on the application.
Step 3	• The Leasing Referral Committee in **PEI**, • the Aquaculture Evaluation Committee in **NB**, or • the Nova Scotia Minister of Agriculture and Fisheries in **NS**	will make the decision to either support, support with conditions or reject the application and will communicate an explanation to the applicant.

* During the initial lease approval stage, federal authorities may be required to issue authorization for aquaculture activities related to the following:

- environmental assessments, under the *Canadian Environmental Assessment Act* (*CEAA*),
- navigable water approvals, under section 5(1)of the *NWPA,* and

[1] The Leasing Referral Committee is composed of members from DFO: Conservation and Protection Branch; Habitat Branch (*Canadian Environmental Assessment Act*); Canadian Coast Guard – Navigable Waters Program; a secretary; and members from PEI Department of Fisheries, Aquaculture and Environment: Fisheries and Aquaculture Division; and Water Resources Division. The Chief, Aquaculture Division is also in attendance to provide information as required.

[2] The Technical/financial Committees are sub-committees of the Nova Scotia Aquaculture Development Committee (NSADC), which consists of members representing government departments and agencies who have regulatory, development, research and potential funding involvement regarding aquaculture. Members represented are: NS Dept. of Agriculture and Fisheries; Dept. of Fisheries and Oceans (including Canadian Coast Guard); National Research Council (IRAP); NS Dept. Economic Development and Tourism; Human Resource Development Canada; Federal Business Development; Bank Canada; ACOA; Sustainable Economic Development; Industry Canada; Environment Canada; Farm Credit Corporation; Aquaculture Association of NS; Enterprise Cape Breton; National Research Council (IMB).

- the possibility of a harmful alteration, disruption or destruction (HADD) of fish habitat under section 35 of the *Fisheries Act*,

The federal government must also assess the impact of proposed aquaculture sites with respect to a number of other matters including, native rights and land claims, migratory birds, utilization by other groups, and shellfish food safety.

3.3.2 a) NWPA review

The approval process is intended to ensure that any interference created by the work in question is acceptable, and the rights of other users of the waterway are respected. Any works undertaken in a navigable waterway must receive Coast Guard approval prior to its construction. The type of approval required and the process to be followed will vary depending on the type and complexity of the proposed work. The formal approval process is followed when a Coast Guard Official determines that the work is considered to "substantially interfere with navigation", or the work is named in the Act. Most suspension-type aquaculture operations, such as mussel longlines would appear to fall within this determination.

3.3.2 b) CEAA review

Under the *CEAA*, environmental assessments are initiated when there is a "trigger " as a result of the federal government carrying out a project, providing financial assistance, issuing a permit or licence, providing land, etc. The department whose action results in triggering the environmental assessment (EA) is responsible for managing the environmental review process. An example of a CEAA trigger is the issuance of an approval under section 5(1) of the *NWPA*.

The type of EA required will vary with the complexity of project, as well as with its possible environmental effects. The vast majority of marine aquaculture projects require an EA and are assessed relatively quickly by undergoing what is known as a screening type of assessment. A screening is a systematic approach to documenting the environmental effects of a proposed project by determining the need to modify the project plan or by recommending further assessment, through mediation or a panel review, to minimize or mitigate these effects. A comprehensive study or review by an independent EA review panel or mediator will be required:

- for projects of large-scale, complex, and environmentally sensitive,
- if it is uncertain that a project is likely to cause significant adverse environmental effects, or
- if public concern warrants (the public is involve so their concerns are taking into consideration during the decision-making process).

Upon completion of the assessment and review, the responsible authority must determine whether the project is likely to cause significant adverse environmental effects, after taking into consideration the implementation of mitigation measures. That determination will dictate whether DFO can provide the NWPA approval and/or the *Fisheries Act* authorization.

3.3.3 Distribution of Leases

Compared to Eastern NB and Gulf NS, mussel culture has evolved more extensively in PEI where the depth and quality of water and shelter is adequate for this kind of operation. Eighty-four percent of the Gulf Region's total leased areas are located in PEI, 10% in Eastern NB, and 6% in Gulf NS. A few of these leases (around 5%) are for seed collections, but for the most part they are off-bottom leases.

Table 2 shows the breakdown of mussel aquaculture sites (leases) in the Gulf Region.

Table 2. Mussel leases Issued by Area, Gulf Region – 2002[1]

AREA	Number	Hectares[2]	Average Hectares per Site
Prince Edward Island	302	4,498	14.89
Eastern New Brunswick	25	518	20.72
Gulf Nova Scotia	8	369	46.13
TOTAL	**335**	**5,384**	**16.07**

Notes: (1) Numbers for Eastern NB are from August 2001. (2) 1 hectare is equal to 2.47 acres.

In PEI, the greatest number of leases are found from Malpeque Bay to St. Peters Bay on the north shore and from Boughton River to Murray River on the eastern end of the province (Figure 7). It is estimated that over 90% of the sites suitable for mussel culture and meeting the leasing criteria are already leased.

In Eastern NB, mussel is not the primary specie cultured and most sites that are involved in the culture of mussels are also growing oysters. Mussel leases in New Brunswick are concentrated on the Southeast shore, near Shediac and on the Northeast shore, near Shippagan in the Acadian Peninsula. The Bay with the greatest number of mussel leases is Shediac Bay, but cover a smaller area than leases found in Shippagan Bay/Sea Arm. Other large areas of mussel leases are found in Bay du Vin and Miscou Harbour. Figure 8 shows an approximation of where the leases are found and Appendix 1 provides the complete list of aquaculture mussel sites in Eastern NB by location and sizes.

In Gulf NS, all mussel sites are located in Tatamagouche Bay, except for one site located in Chance Harbour and another in the Strait of Canso North. Figure 9 shows an approximation of where the leases are found and Appendix 2 provides the complete list of aquaculture mussel sites in Gulf NS by location and sizes.

Figure 7. Mussel leases in Prince Edward Island

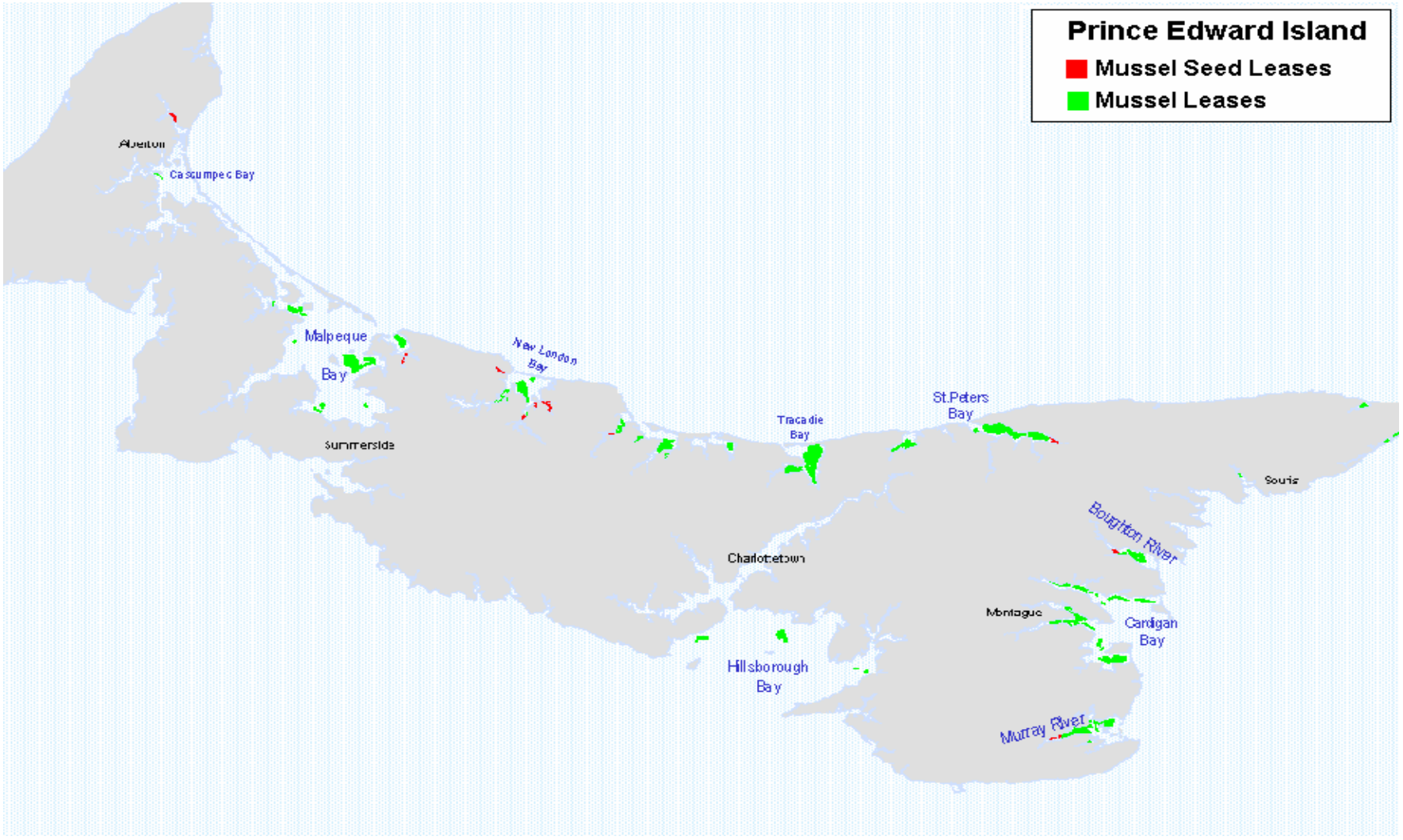


Figure 8. Mussel Leases in Eastern New Brunswick

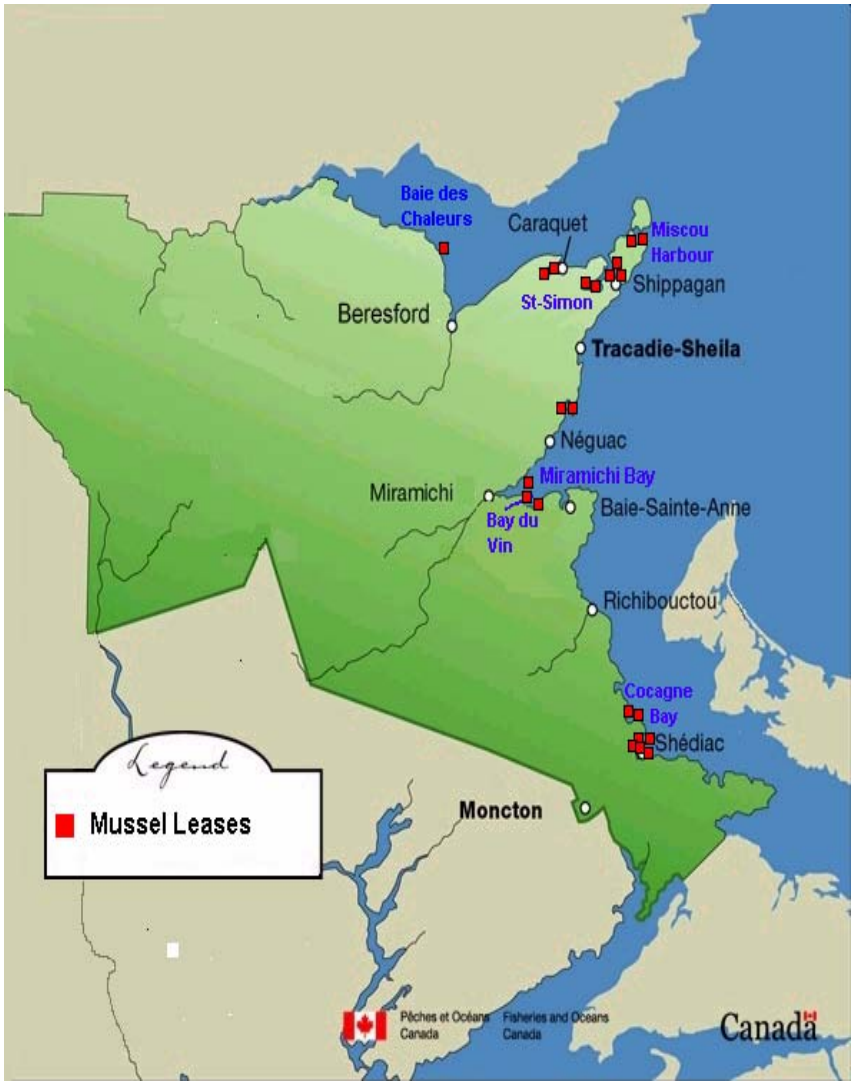
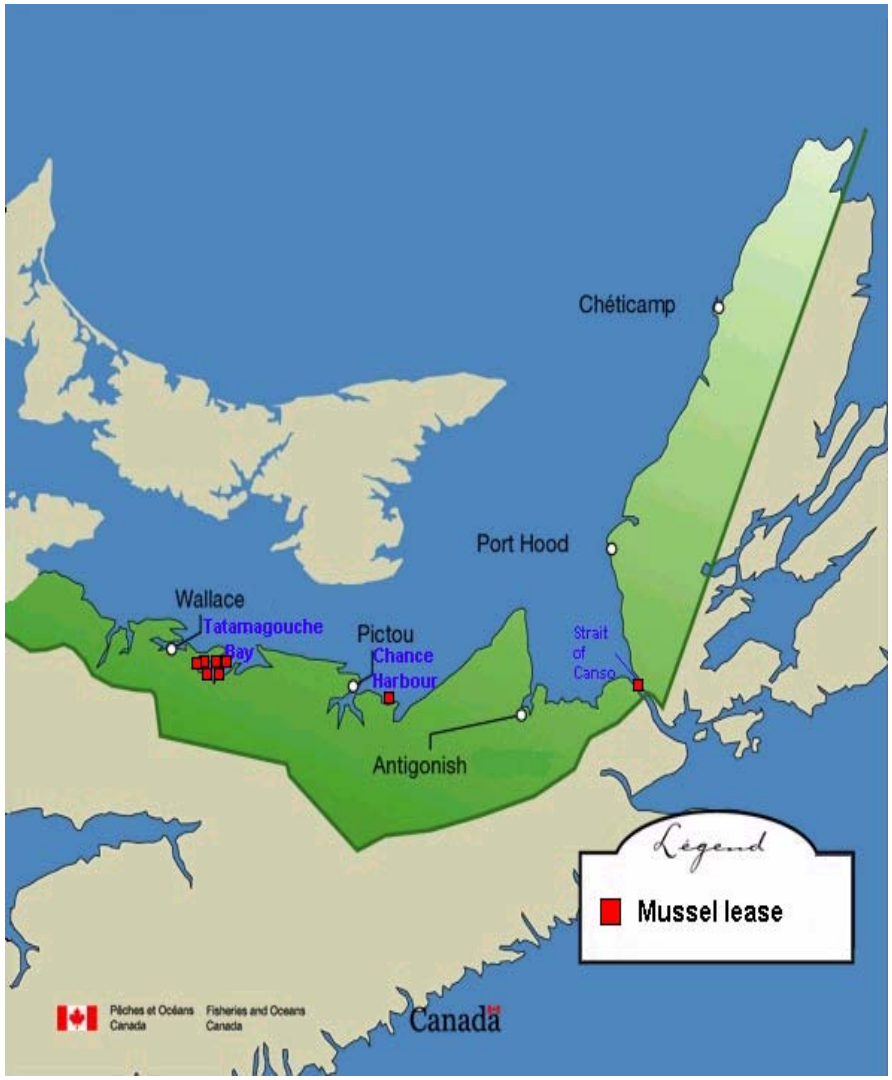


Figure 9. Mussel Leases in Gulf Nova Scotia



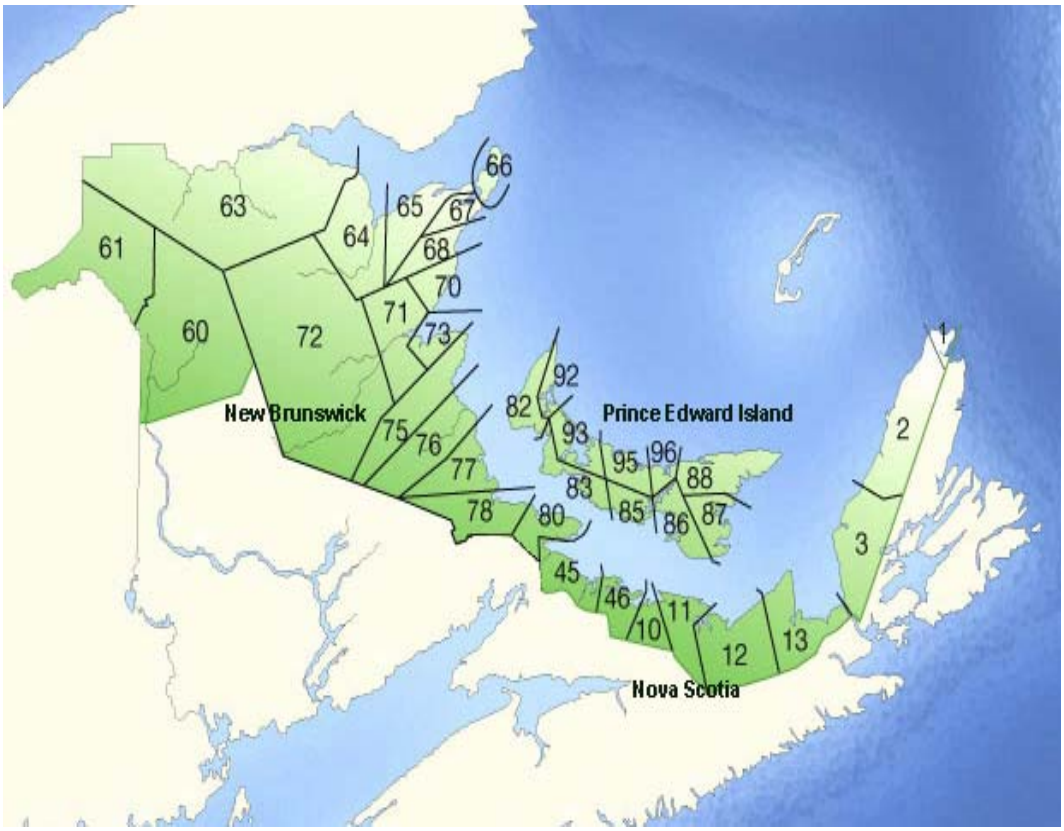
Chapter 4 – Statistics

4.1 Mussel Fishers and Growers

4.1.1 Fishers

Figure 10 illustrates the distribution of the 922 commercial mussel fishers (in red) by statistical district (in black). In addition to the 15 communal mussel licences in PEI, there are 689 mussel fishers in PEI, 224 in Eastern NB, and 9 in Gulf NS. Geographical boundaries of the Gulf Region's districts are described in Appendix 3.

Figure 10. Statistical Districts



Number of Fishers with Commercial Mussel Licences - 2002															
	District	82	83	85	86	87	88	96	95	93	92	-			
	PEI	**50**	**192**	**29**	**47**	**52**	**37**	**11**	**21**	**104**	**146**				
	District	63	64	65	66	67	68	70	71	73	75	76	77	78	80
	Eastern NB	**3**	**0**	**1**	**5**	**11**	**5**	**37**	**5**	**39**	**32**	**20**	**41**	**4**	**21**
	District	45	46	10	11	12	13	3	2	1	-				
	Gulf NS	**0**	**2**	**2**	**2**	**1**	**1**	**0**	**0**	**1**					

4.1.2 Growers and Employees

The 302 mussel leases in PEI are being held by 142 leaseholders/companies. It is estimated that these growers employed around 1,000 people directly on their mussel aquaculture operations. In addition, there are approximately 400 people in PEI working in mussel processing plants.

In Eastern NB, it is estimated that there are six commercial mussel aquaculture operations, three of which are of larger scale. Keeping in mind that the owners of these mussel aquaculture operations often use the same personnel for their mussel and oyster operations, a recent study found there were around 48 people in 2001 employed directly on these mussel operations during the peak season.

In Gulf NS, the 8 mussel leases are being held by 2 individuals and 4 companies. And, it is estimated that in 2001 there were 4 full-time and 17 part-time jobs, for a total of 21 people that were working on mussel aquaculture operations.

4.2 Mussel Production

The aquaculture production statistics in this document was provided by Statistics Canada[3], which reports on a provincial basis only. However, because there is no cultured mussel in the Bay of Fundy, the data reported for NB is considered representative of Eastern NB. Statistics for Gulf NS was provided directly by the Nova Scotia Department of Agriculture and Fisheries.

Table 3 shows that PEI is clearly the leading mussel producer in the country.

Table 3. Production of Cultured Mussels, Distribution by Province, Canada – 2001

PROVINCE	Quantity	Value
Prince Edward Island	80.8%	76.1%
Newfoundland	6.7%	12.9%
Nova Scotia	7.5%	6.6%
New Brunswick	3.5%	2.7%
Quebec	1.6%	1.7%
Others	-	-
CANADA	**100%**	**100%**

[3]For more information on aquaculture statistics go to DFO's Statistical Services Web page: http://www.dfo-mpo.gc.ca/communic/statistics/stat_e.htm. For more information on how these statistics are collected see Statistics Canada Catalogue no. 23-222-XIE, which can be found at: http://www.statcan.ca/english/freepub/23-222-XIE/free.htm.

4.2.1 1992 versus 2001

Table 4 shows that PEI's production increased significantly since 1992, although its share of the Gulf Region's total production decreased slightly (by 1.1%). Mussel production in Eastern NB remains relatively small, although it slightly increased (by 1.2%) its share of production. As for mussel production in Gulf NS, it is minimal (less than 1.3 metric tons), as the province's mussel production is almost entirely concentrated outside the Gulf area. Overall, the Gulf Region's mussel production in 2001 was more than 4 times the quantity and value generated in 1992.

Table 4. Production of Cultured Mussels, Gulf Region – 1992 versus 2001

Area	Quantity (mt)		% Change 1992-2001	Distribution (%)	
	1992	2001		1992	2001
Prince Edward Island	4,186	17,506	**318%**	97.0%	95.9%
Eastern New Brunswick	125	750	**500%**	2.9%	4.1%
Gulf Nova Scotia	4	(C)	**N/A**	0.1%	(C)
GULF REGION	**4,315**	**18,256**	**323%**	**100%**	**100%**

Area	Value ($000)		% Increase	Distribution (%)	
	1992	2001	1992-2001	1992	2001
Prince Edward Island	4,959	23,200	**368%**	97.3%	96.6%
Eastern New Brunswick	130	825	**535%**	2.6%	3.7%
Gulf Nova Scotia[4]	6	(C)	**N/A**	0.1%	(C)
GULF REGION	**5,095**	**24,025**	**372%**	**100%**	**100%**

4.2.2 1996 to 2001

Table 5 shows that PEI is producing much more mussels than Eastern NB and Gulf NS and that the Province's mussel production increased 99% from 1996 to 2001. As a whole, production in Gulf Region doubled for the same period. In the last few years alone (1999 to 2001) the value of mussel production in the Gulf Region increased a little more than 36%.

Between 1996 and 2001, the average price of cultured mussels paid by registered provincial and/or federal buyers in the Gulf Region fluctuated from a low of $1.18/kg in 2000 to a high of $1.32/kg in 2001.

Table 5. Production of Cultured Mussels, Gulf Region – 1996 to 2001

Area	Quantity in Metric Tons					
	1996	1997	1998	1999	2000	2001
Prince Edward Island	8,817	9,974	12,459	13,890	17,895	17,506
Eastern New Brunswick	147	137	680	665	1,252	750
Gulf Nova Scotia[4]	1	0	0	0	0	(C)
GULF REGION	**8,965**	**10,111**	**13,139**	**14,555**	**19,147**	**18,256**

Area	Value in Thousands of Dollars ($'000)					
	1996	1997	1998	1999	2000	2001
Prince Edward Island	10,693	12,096	15,110	16,845	21,703	23,200
Eastern New Brunswick	103	108	1,455	798	825	825
Gulf Nova Scotia[4]	1	1	0	0	1	(C)
GULF REGION	**10,797**	**12,205**	**16,565**	**17,643**	**22,529**	**24,025**

4.3 Product

Because the quality for consumption of the meat is usually higher between October and June, there is not always a year-round supply of mussels. However, advances in shellfish bivalve aquaculture in the last ten years have enabled the more aggressive producers to grow a quality product that allows year-round harvesting, which in turn allows year-round market access.

In the Gulf Region, there has been some attention put towards value-added mussel products such as partially cooked mussel in a prepared sauce or in their own juices, smoked mussels, pasteurized mussels, and more recently, blast frozen cooked mussels. For the most part however, mussels are still sold fresh in the shell.

There are approximately 21 plants processing mussels in PEI, six in Eastern NB (of which one is selling smoked mussels and another is selling pasteurized mussels) and one in Gulf NS. Mussels are usually transported to a plant where they go through different processing machines. Fresh mussels are generally placed in mesh bags, which allow for drainage and ventilation before they are packed into master cartons for shipment. Operators however, are sometime responsible to wash and declump their own stock prior to delivery and some markets even prefer that the mussels are debyssed, which usually add costs. To get the cooked/frozen type of product offered by a few plants, the mussels are generally placed in pouches that are sealed under vacuum and that undergo a specific cooking and chilling process. After processing, the mussels are ready to be transported to nearby markets in insulated refrigerated trucks or in most cases by air.

[4](C) Confidential: the 2 counties (Cumberland & Pictou) with production had 3 or less active growers per county. The total for Gulf Nova Scotia is less than 1.3 mt. N/A: Not Available due to confidentiality.

4.4 Domestic Markets

The amount of mussels from the Gulf Region that are sold locally is minimal compared to the amount sold to large Canadian urban centres. The main Canadian destinations are Quebec City, Montreal, Toronto, Calgary, and Vancouver.

4.5 Exports[5]

The following market analysis will expand beyond the Gulf Region, focusing on the three Maritime Provinces because data on exports are only available on a provincial basis. Also, it is important to note that mussels exported from one province to another country does not necessarily mean that these mussels were harvested or processed in that province.

4.5.1 Major Canadian Exporters

In the last five years increasingly more mussels are being exported, principally to the United States (U.S.). The principal Canadian exporter is Prince Edward Island. In 2001, this province exported more than $22.5 Million worth of mussels, representing over 90% of Canada's total (Table 6). Nova Scotia, Newfoundland and New Brunswick combined are the next biggest exporters, contributing together close to 8% of Canadian exports.

Table 6. Mussel Export Values, Distribution by Province, Canada – 1997 to 2001

Province	1997	1998	1999	2000	2001
Prince Edward Island	88.5%	85.4%	84.5%	83.3%	90.4%
Nova Scotia	1.2%	2.7%	3.9%	5.9%	3.5%
Newfoundland	4.2%	5.2%	6.4%	5.2%	2.6%
New Brunswick	6.1%	6.2%	2.9%	2.5%	1.8%
Quebec	0.1%	0.3%	2.2%	2.7%	1.1%
Ontario	0.0%	0.3%	0.0%	0.2%	0.5%
British Columbia	0.0%	0.0%	0.1%	0.2%	0.2%
Manitoba, Saskatchewan, Alberta and the Territories	-	-	-	-	-
TOTAL CANADA	**100%**	**100%**	**100%**	**100%**	**100%**

[5] Only domestic exports are included, which consist of the "exports of all goods grown, produced, extracted or manufactured in the country, leaving the country for a foreign destination. Exports of imported merchandise which has been substantially enhanced in value are also included".

Source: Statistics Canada (adapted from Strategis: www.strategis.gc.ca).

While the value of exports in 2001 increased 15% from the previous year in PEI, it was down 28% and 59% in NB and NS respectively. As a whole, the Maritime Provinces' exports increased significantly in value from 1997 to 2001 (Table 7). In fact, Maritimes' value in 2001 was almost doubled that of 1997.

Table 7. Mussel Export Values (in thousands of dollars)
by Province, Canada – 1997 to 2001

Province	1997	1998	1999	2000	2001	Rank in 2001
Prince Edward Island	11,224	13,122	14,706	19,529	22,486	**1**
New Brunswick	773	953	504	584	458	**4**
Nova Scotia	149	411	684	1,373	863	**2**
Total Maritime Provinces	12,146	14,486	15,893	21,486	23,808	**-**
Newfoundland	529	795	1,106	1,229	639	**3**
Quebec	7	45	379	641	274	**5**
Ontario	4	47	4	49	127	**6**
British Columbia	3	-	19	47	38	**7**
Manitoba, Saskatchewan, Alberta and the Territories	-	-	-	-	-	**-**
TOTAL CANADA	**12,689**	**15,373**	**17,402**	**23,452**	**24,886**	

Table 8 shows how export values are distributed among the three Maritime Provinces.

Table 8. Mussel Export Values,
Distribution by Province, Maritimes – 1997 to 2001

Province	1997	1998	1999	2000	2001
Prince Edward Island	92.4%	90.6%	92.5%	90.9%	94.4%
New Brunswick	6.4%	6.6%	3.2%	2.7%	1.9%
Nova Scotia	1.2%	2.8%	4.3%	6.4%	3.6%
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**

4.5.2 International Destinations

The majority of mussels are exported live. In 2001, close to 94% of mussels from the Maritimes were exported this way. Japan however receives the majority of its mussels frozen. Appendix 4 shows the value of mussel exported by PEI, NB and NS by type of mussel product (live and frozen) and by destination for 1997 to 2001.

As Table 9 shows, the U.S. receive most mussels exported by PEI, NB and NS. In 2001, close to 92.8% of Maritimes' mussel exports were transported to the US and 6.9% to Japan.

Table 9. Mussel Export Values (in thousands of dollars)
by Province and by Destination, Maritimes – 1997 to 2001

Destination	1997	1998	1999	2000	2001
United States	11,213	12,936	14,018	19,036	21,404
Japan	-	-	69	397	1,078
France (includes Monaco & French Antilles)	-	186	573	97	-
Others	11 (Belgium)	-	45 (Israel)	-	4 (Hong Kong)
Total Prince Edward Island	**11,224**	**13,122**	**14,706**	**19,529**	**22,486**
United States	773	946	242	381	92
Japan	-	7	262	202	366
Total New Brunswick	**773**	**953**	**504**	**584**	**458**
United States	147	411	520	583	600
Japan	-	-	127	789	220
France (includes Monaco & French Antilles)	-	-	-	-	13
Belgium	-	-	-	-	18
Others	2 (Singapore)	-	37 (U.K)	-	12 (Israel)
Total Nova Scotia	**149**	**411**	**684**	**1,372**	**863**
United States	12,132	14,293	14,780	20,001	22,095
Japan	-	7	458	1,388	1,664
France (includes Monaco & French Antilles)	-	186	573	97	13
Others	14	-	81	-	35
GRAND TOTAL	**12,146**	**14,486**	**15,893**	**21,486**	**23,808**

Appendix 5 (a,b,c) illustrates the history (1992 to 2001) of Maritimes' mussel export values by destination and by province. Since 1993, more than 94% of PEI mussel export's values have been going to the U.S. The other 6% have been distributed among Japan, France, Israel, and Belgium.

Since 1992, NB's mussel exports have also been going principally to the U.S; some exceptions are in 1995, when 9.3% went to Cuba and in 1996, when 2.0% went to Israel. In the last four years, NB's exports have increasingly been going to Japan. In fact in 1999 and 2001, the mussels exported to Japan were worth more than those exported to the U.S.

Between 1992 and 1998, more than 95% of NS mussel export's values have been going to the U.S., except in 1995 when 25% worth of mussels was exported to Japan, which is the second most important destination for Nova Scotia. Actually in 2000, more mussels were exported to Japan than to the U.S.

4.5.3 United States Destinations

For the past five years, the majority of the Maritime Provinces' mussel exports have been going two U.S. destinations, which are Massachusetts and Maine (Table 10).

Table 10. Mussel Export Values (in dollars) **to the United States by Province and by Main Destinations, Maritimes – 1997 to 2001**

Destination	1997	1998	1999	2000	2001
Massachusetts	4,116	5,170	5,036	7,316	8,592
Maine	3,910	4,210	5,219	6,370	7,541
New York	893	1,054	1,169	1,586	1,823
California	518	860	852	848	799
Florida	196	442	562	986	776
Georgia	277	386	431	397	535
Rhode Island	488	207	92	482	303
Others	826	792	1,346	1,546	2,118
Total PEI	**11,224**	**13,122**	**14,706**	**19,529**	**22,486**
Massachusetts	326	71	218	289	63
Maine	54	115	14	50	29
California	-	4	-	27	-
Rhode Island	339	710	4	-	-
Indiana	50	47	-	-	-
Others	4	7	268	218	366
Total NB	**773**	**953**	**504**	**584**	**458**
Massachusetts	56	99	135	335	514
Maine	78	190	182	89	82
Florida	-	-	-	80	4
Rhode Island	6	19	160	49	-
California	-	45	27	22	-
Others	9	58	179	796	264
Total NS	**149**	**411**	**684**	**1,373**	**863**
Massachusetts	4,498	5,340	5,389	7,941	9,168
Maine	4,042	4,515	5,415	6,509	7,652
New York	893	1,054	1,169	1,586	1,823
California	518	909	879	897	799
Florida	196	442	562	1,066	779
Georgia	277	386	431	397	535
Rhode Island	833	936	256	531	303
Others	890	904	1,792	2,560	2,748
TOTAL MARITIMES	**12,146**	**14,486**	**15,893**	**21,486**	**23,808**

Chapter 5 – Research, Technology and Education

Following is a list of some of the research projects, programs and facilities that contribute to the development of bivalve molluscs in the Gulf Region.

5.1 Department of Fisheries and Oceans

5.1.1 Shellfish Health Unit

One of only two laboratories in Canada which specialize in shellfish health is located within the Gulf Region in Moncton, New Brunswick. The Shellfish Health Unit examines all species of bivalve molluscs for parasites, pests and diseases. This enables them to compile health profiles for both normal and unhealthy molluscs. This information acts as a reference base for determining the best approaches to avoid the introduction and spread of disease, as well as manage diseases that are already present.

Recent work has concentrated on soft-shelled clams, hard-shelled clams (quahaugs) and bar clams, however, the shellfish health team still spends much of their time on species which are harvested commercially or cultured traditionally such as mussels and oysters.

In addition to keeping an eye on the health of Atlantic bivalve molluscs, the Shellfish Health Unit is also frequently called upon to give health advice and training to developing shellfish industries elsewhere in the world. In recent years, the shellfish pathology research scientist from Shellfish Health Unit has been involved with the Food and Agricultural Organization (FAO) of the United Nations in the development of guidelines and operating procedures to minimize the risks of disease with transfers of live aquatic animals throughout the Asia-Pacific region. In addition, this scientist has been invited to investigate mass mortalities of pearl oysters in Japan and the Philippines. All this experience is valuable for managing disease problems and advising on the development of *National Aquatic Animal Health* programs for Canada.

5.1.2 Validating Fish & Shellfish Health Tests

Effective regulations that allow DFO to monitor the health of fish and shellfish are in place in Canada. The tests currently available to identify and detect disease agents are constantly changing as new techniques are developed. The advantage of newer methods (using biomolecular techniques) is that they are more sensitive and more specific than traditional tests. However, the new tests need to be validated to determine how specific and how sensitive they are.

When laboratories diagnose human and animal disease agents, they use standard methods. DFO's scientists are working with other agencies to establish similar guidelines for the testing of fish and shellfish disease agents. In collaboration with the Atlantic Veterinary

College, the Research and Productivity Council and others, scientists are drafting protocols so that a consistent testing procedure will exist for all laboratories. Once these standards are in place, these new tests will provide accurate tools to detect and identify pathogens in fish and shellfish.

5.1.3 Aquaculture Collaborative Research and Development Program (*ACRDP*)

The *ACRDP* is a DFO initiative to increase the level of collaborative research and development activity between the aquaculture industry and the department and in some instances with other key funding partners. *ACRDP* is an industry-driven program that will pair industry with DFO researchers. Projects are conducted at DFO Research facilities or possibly industry partner facilities.

The key goals of the program are to

- improve the competitiveness of the Canadian aquaculture industry,
- increase collaboration between the department and industry on scientific research and development that will enhance aquaculture in Canada,
- facilitate and accelerate the process of technology transfer and research commercialisation through closer collaboration with the Canadian aquaculture industry, and
- increase scientific capacity for essential aquaculture research and development in the aquaculture sector.

DFO approved under the first two rounds of the ACRDP for the 2002-2003 fiscal year, $7.5 million worth of projects. The industry's financial contribution for the projects is 25% of the total cost to conduct the research. The variety of approved projects demonstrates a balance in addressing the three key industry priorities: aquaculture production, fish health and environmental issues. The projects focus on marine salmonids and finfish, as well as molluscs and other species, and some projects are also conducted in fresh water aquaculture. These projects will contribute significantly to the research necessary for Canada's aquaculture industry to increase its competitiveness in international markets.

Regionally, the three following projects relating to mussels have been approved:

Title and Description	Industry Collaborators (Province)	Project Duration	ACRDP Project Funding
1) *Development and evaluation of standardized monitoring and data acquisition systems for the management of mollusc culture in Atlantic Canada.* The performance of mussels (growth and survival) is influenced by husbandry and environmental conditions. This study will develop a series of standardized protocols for the monitoring of mussel growth, survival and yield in relation to husbandry and environmental conditions on several mussel grow-out sites.	PEI Aquaculture Alliance (PEI)	4 years	$390,400
2) *Predator and competitor interaction with bivalve culture: development of an effective management approach.* The impact of predators, such as sea stars and crabs, and competitors, such as tunicates, on bivalve farming (mussels and oysters) is significant. The presence of both predators and competitors can result in decreased growth and survival. This project is designed to examine the life cycle of key predators and competitors. It will also develop management strategies that farmers can use to reduce the impact of these predators and competitors.	PEI Aquaculture Alliance (PEI)	4 years	$234,200
3) *Parasites affecting Maritime mussel aquaculture development and movements.* Since the 1980s, wild and cultured mussels in the Maritimes have been examined for their health status. Recently a digenean parasite was found in mussels in one Maritime aquaculture site. This parasite is known to affect the health and survival of mussels. This project will examine the distribution and life cycle of this parasite and determine if the infection of mussels is related to size or environmental factors. It will also examine the risk of the parasite establishing at new sites.	Aquaculture Association of Nova Scotia (NS) and PEI Aquaculture Alliance (PEI)	4 years	$151,000

5.2 Provincial Departments of Fisheries

5.2.1 PEI Department of Fisheries, Aquaculture and Environment

The Aquaculture Section of the PEI Department of Fisheries, Aquaculture and Environment delivers programs to assist in the development of the aquaculture industry such as the:

- Aquaculture Technology Program: an incentive for aquaculture operators to adopt new techniques or technologies or to assess new approved species.
- Aquaculture Diversification Program: an incentive to stimulate diversification within the aquaculture sector through commercializing developmental species.
- Mussel Monitoring Program: a technical service to mussel producers and processors to provide information on spatfall, water quality, meat yield and presence of "potentially toxic" phytoplankton.

5.2.2 NB Department of Agriculture, Fisheries and Aquaculture (DAFA)

The DAFA has a team of professionals assigned to aquaculture development and to biology technology transfer research. The majority of the staff, working from the Aquarium and Marine Centre, offers the industry a range of services and does research and development work on fish and mollusc farming in the natural environment, as well as in the wet or dry high-tech laboratories. In addition, a bivalve shellfish hatchery makes it possible to breed shellfish under artificial conditions. This tool is used to develop shellfish rearing techniques designed to maximize production of spat in hatcheries, and later, of fry in the natural environment.

Disease diagnosis, spatfall prediction, and site evaluation are among the many services offered to the aquaculture industry by the Fisheries and Aquaculture staff working at the Aquarium. The objective of these activities is to optimize the performance of New Brunswick's aquaculture industry in order to make it more competitive on national and international markets.

5.2.3 NS Department of Agriculture and Fisheries (DAF)

5.2.3 a) Technology Development Programs

The Nova Scotia DAF offers several Technology Development Programs such as the Technology Transfer Program, Harvesting Technology, Student Initiative, and Aquaculture Development aiming at developing and optimizing the harvesting, processing and recreational sectors of the Nova Scotia fishing and aquaculture industries. This is done through public-private partnerships, technology transfer, applied research and community development programs. For example, the technology group of the

Aquaculture Development works closely with the aquaculture industry on technical development projects conducted jointly by industry and the department. These projects enable participating mollusc and finfish growers to safely market their products.

5.2.3 b) Fisheries and Aquaculture Services

The Fisheries and Aquaculture Services has for mission *"to service, develop and manage the harvesting processing, recreational and aquaculture segments of the Nova Scotia fishing industry for the betterment of our coastal communities and the province overall."* It conducts a 40-week Aquaculture Mentorship program using Nova Scotia Agricultural College (NSAC) campus in Pictou and using established aquaculture farms in areas throughout the province. Clients spend a total of 10 weeks in the classroom in Pictou, where trained instructors and featured guest speakers offer information ranging from safety procedures, veterinary skills to entrepreneurship, record keeping and managing a small business. Then, they spend the remaining 30 weeks on location with their mentors working on the farm, learning first hand the techniques, schedules, procedures, problems and solutions aquaculturists encounter every day.

5.3 Academia and Research Facilities in the Gulf Region

5.3.1 Canadian Aquaculture Institute

Locally and around the world, the Canadian Aquaculture Institute (CAI) in PEI delivers professional training to the aquaculture industry. The CAI *Training Programs* have offered short courses, seminars and workshops to clients in a variety of aquaculture-related issues such as operational set-up and management, aquatic animal husbandry and nutrition, disease diagnosis and treatment for shellfish and finfish, and selective breeding programs. Courses may include classroom and laboratory components as well as field visits to various facilities. The training is delivered by industry professionals and expert researchers from the Atlantic Veterinary College, the University of PEI and other academic institutions.

5.3.2 Atlantic Veterinary College (AVC) Inc.

The University of Prince Edward Island (UPEI) houses a major player in aquaculture, the private for-profit company AVC Inc. The corporate arm of the UPEI currently has divisions such as the *Atlantic Fish Health, Canadian Aquaculture Institute*, and *Cardigan Water Science Center* involved with Aquaculture Research.

The AVC facility is equipped with the most current equipment available for veterinary studies. There are also other corporate facilities, which manufacture some of the most widely used vaccination and medications for the fishing industry. These companies have built a reputation based on continuing outstanding results. AVC Inc. also provides

consulting services to clients both within the University and externally. These services are very broad in scope and include business services such as contract negotiation and management; scientific analysis of specific problems principally in the areas of aquaculture, fish health, and the environment.

5.3.3 Université de Moncton

The university has three campuses in New Brunswick: Moncton, Shippagan and Edmundston. It offers a Baccalaureate in Sciences (B.Sc.) with specialisation in biology either through the regular program or the coop program, or with major or minor in biology. The biology program offers basic theoretical and practical training in sciences biology that can eventually enable students to orient themselves in more specialised disciplines such as marine biology, aquatic ecology, and aquatic animal physiology. The goal of the coop program is to place the student in a work environment during his or her studies. A master's degree in science (M.Sc.) in biology is also offered and aimed at giving extensive training to the student on a particular aspect of sciences biology.

The members of the biology faculty are actively doing research on aquatic ecology or are applying the results of fundamental research done in different field such as aquaculture of marine invertebrates. The university also hosts several Research Bureau and Research Centers throughout the Province. Two research centers involved in marine products and aquaculture are described below.

5.3.3 a) The Marine Products Research and Development Center Inc. (MPRDC)

The MPRDC, located in Shippagan (NB), is a non-profit organization incorporated in October 1990. Its mission is to provide assistance to the provincial fishery and aquaculture industry in its efforts to diversify existing marine products and commercialize new products from under-utilized and unexploited species living in the Gulf of St. Lawrence.

The MPRDC's mandate is to assist the fisheries and aquaculture industry, mostly in New Brunswick, in its efforts to maintain and improve the quality of its marine products and its efforts to diversify these products. This mandate is realised through technical and scientific assistance in applied research, which helps the development of new products, the transfer of new procedures and/or new technologies. Services such as chemical, microbiological and nutritional analyses are also provided.

5.3.3 b) Centre de recherche sur les aliments (CRA)

The CRA is devoted to food research and to the delivery of services in the Atlantic food industry, particularly in the New Brunswick's industry. Its goal is to assist the processors in apply research, development of new products, as well as chemical, microbiological and sensorial analysis. The CRA offers services in the agri-food and marine products and wants to direct its services towards small and medium enterprises to complement their resources and catalyse on technological innovation.

5.3.4 New Brunswick School of Fisheries

The New Brunswick School of Fisheries was founded in 1959 and its mission reads as follows: "*to ensure training to the fishery and aquaculture industries in New Brunswick and be focused on the industries' needs so that they are economically viable*". Located in Caraquet, the School offers training programs to those persons wanting to obtain a diploma in order to practice or continue practising the profession of fishermen and aquaculturist among others. The School has developed teaching tools to provide necessary training in productivity, efficiency, responsibility and safety so as to meet the growing requirements of the fishery sector.

5.3.5 Mount Allison University

The biology curriculum at Mount Allison University, located in Sackville, New Brunswick, enables the student to develop a Major or a minor in Biology. In addition, the Biology Department also offers Honours B.Sc. and M.Sc. programmes. In the Biology Department, an attempt is made to give all students an understanding of the basic scope, techniques and general principles which underlie biological science, to encourage independent study and self-learning, and to provide opportunities to explore areas of advanced study in such areas as Ecology (freshwater, marine, terrestrial) and Physiology (animals, plants, micro-organisms).

5.3.5 a) Coastal Wetland Institute

Research in the Coastal Wetland Institute is currently concerned with: ecology, evolution and systematics of aquatic organisms; environmental acclimation in aquatic microorganisms, marsh plants, and algae; comparative physiology of fishes and invertebrates; geomorphology and evolution of marine coastlines; environmental chemistry; and wetlands human ecology and management.

5.3.6 St. Francis Xavier University

St. Francis Xavier University (StFX), located in Antigonish, NS, offers a B.Sc. with Major in aquatic resources and in biology, a B.Sc. with Advanced Major in biology, a B.Sc. with Honours in biology, and a M.Sc. (biology). The Department of Biology offers courses intended for the preparation of students interested in advanced work in biology, courses which satisfy the requirements of students in professional and pre-professional programs, and courses of general educational interest.

5.3.6 a) Strategic Research Plan - Canada Research Chairs Program

StFX is planning a new science building which will house three of the University's Canada Research Chairs (CRCs). The Academic Priorities and Planning Committee (APPC), of StFX identified seven existing areas of research strengths for enhancement

over the next five years through the CRC program. One of the seven Research Thrusts for CRCs is in aquatic ecology which is allied with the Biology Department.

5.3.6 b) Social Research for Sustainable Fisheries (SRSF)

SRSF is a Community-University Research Alliance (CURA) based out of Antigonish (NS) that partners Mi'kmaq and non-native fish harvesters organizations with StFX University's research capacity and know-how as well as with the research and educational expertise affiliated with Interdisciplinary Studies in Aquatic Resources (ISAR). A core purpose of the partnership is to develop applied research capacity within and research relations between marine harvesting community organizations and the university community.

Conclusion

The Gulf Region has long supported the fisheries and culture of several molluscan species such as oysters, clams, and Blue mussels, the specie of interest in this profile.

As we have seen, the Blue mussel is the most important molluscs cultivated in the Gulf Region not only in term of landed value, but also in term of employment.

In the last two decades, PEI has developed the aquaculture industry so intensively that, at this time, it is believed that the limit of expansion of mussel leases has nearly been reached. Future growth in production will only happen with further development of present technologies or of new technologies allowing the use of offshore waters; sites located in waters that are now considered too exposed to wind and ice, and if insurance of co-existence with other stakeholders continues. As well, future development of the mussel industry will have to be tied to the processing of mussels. As for Eastern NB and Gulf NS, their number of mussel operations has not been increasing as rapidly as PEI, but the two areas existing waters and sheltered coastlines is still promising for mussel aquaculture development.

Moreover, regulations and programs to manage and conserve the resource, as well as to protect the industry and the public at large are continuously being improved. Numerous collaborative aquaculture and bivalve shellfish researches and developments are also happening in and around the Gulf Region. All of this will continue to increase scientific capacity and help support, as well as improve the competitiveness of the mussel industry in the Gulf Region.

APPENDICES

Appendix 1

Eastern New Brunswick Aquaculture Mussel Sites - 2001

Location	Species	Size		Percent of Total
		Hectares	Acres	
Shippagan Bay	Blue Mussel American Oyster Deep Sea Scallop	73,09	180,61	
	Blue Mussel Europeen Oyster	37,26	92,07	
(Sea arm)	Blue Mussel American Oyster Deep Sea Scallop Bay Scallop	45,16	111,59	
Total - Shippagan Bay (& Sea arm)**:**		**155,51**	**384,27**	**30,0%**
Bay du Vin	Blue Mussel	60,46	149,40	
	Blue Mussel	27,00	66,72	
Total - Bay du Vin:		**87,46**	**216,12**	**16,9%**
Miscou Harbour	Blue Mussel Deep Sea Scallop	34,66	85,65	
	Blue Mussel	33,38	82,48	
Total - Miscou Harbour:		**68,04**	**168,13**	**13,1%**
Shediac Bay	Blue Mussel American Oyster Bar Clam Quahog	13,10	32,37	
	Blue Mussel American Oyster Bar Clam Quahog	11,80	29,16	
	Blue Mussel American Oyster	13,10	32,37	
	Blue Mussel American Oyster	10,12	25,01	
	Blue Mussel American Oyster Quahog	7,73	19,10	
Total - Shediac Bay:		**55,85**	**138,01**	**10,8%**
Caraquet Bay	Blue Mussel American Oyster	2,59	6,40	
Caraquet Harbour	Blue Mussel American Oyster	29,75	73,51	
Total - Caraquet Bay & Harbour:		**32,34**	**79,91**	**6,2%**
Neguac Bay	Blue Mussel American Oyster Soft-Shell Clam Quahog	12,40	30,64	
	Blue Mussel American Oyster	16,70	41,27	
Total - Neguac Bay:		**29,10**	**71,91**	**5,6%**

Appendix 1 (continued)

Eastern NB Aquaculture Mussel Sites

Location	Species	Size		Percent of Total
		Hectares	Acres	
Miramichi Bay	Blue Mussel	24,00	59,31	
Total - Miramichi Bay:		**24,00**	**59,31**	**4,6%**
Chaleurs Bay	Blue Mussel Europeen Oyster	21,08	52,09	
Total - Chaleur Bay:		**21,08**	**52,09**	**4,1%**
Anse St-Simon	Blue Mussel American Oyster	2,43	6,00	
	Blue Mussel American Oyster	16,22	40,08	
Total - Anse St-Simon:		**18,65**	**46,09**	**3,6%**
Cocagne Bay	Blue Mussel American Oyster Quahog	8,28	20,46	
Cocagne Harbour	Blue Mussel American Oyster Bar Clam Quahog Deep Sea Scallop	9,71	23,99	
Total - Cocagne Bay & Harbour:		**17,99**	**44,45**	**3,5%**
Peacock Cove	Blue Mussel American Oyster	7,53	18,61	
Total - Peacock Cove:		**7,53**	**18,61**	**1,5%**
Caribou Bay	Blue Mussel American Oyster Bar Clam Quahog Soft-Shell Clam	0,00		
Total - Caribou Bay:		**0,00**		**0,0%**
New Horton	Blue Mussel American Oyster Soft-Shell Clam	0,00		
Total - New Horton:		**0,00**		**0,0%**
GRAND TOTAL:		**517,55**	**1 278,89**	**100%**

Source: NB Department of Agriculture, Fisheries & Aquaculture.
Last Update: August, 2001

Appendix 2

Gulf Nova Scotia Aquaculture Mussel Sites - 2002

Location	Species	Size		Percent of Total (%)
		Hectares	Acres	
Tatamagouche Bay	Blue Mussels American Oysters Bay Quahog	14,77	36,50	
	Blue Mussels American Oyster Bay Quahog Clams (Soft Shell)	50,50	124,79	
	Blue Mussels	82,30	203,37	
	Blue Mussels American Oysters	111,70	276,02	
	Blue Mussels American Oysters	85,51	211,30	
	Blue Mussels	8,11	20,04	
Total - Tatamagouche Bay:		**352,89**	**872,01**	**95,8%**
Chance Harbour	Blue Mussels American Oysters Bay Quahog	0,73	1,80	
Total - Chance Harbour:		**0,73**	**1,80**	**0,2%**
Strait of Canso North	Blue Mussels American Oysters Sea Scallops	14,88	36,77	
Total - Strait of Canso North:		**14,88**	**36,77**	**4,0%**
GRAND TOTAL		**368,50**	**910,58**	**100%**

Source: Nova Scotia Deptarment of Agriculture and Fisheries - Aquaculture Site Mapping.
Last Update: January 17, 2002

Appendix 3

Gulf Region Statistical District Boundaries

Gulf Nova Scotia Statistical District	Geographical Boundary
01	Meat Cove to Bay St. Lawrence
02	Victoria County to Broad Cove
03	Broad Cove (inclusive) to Richmond County
10	Cumberland County to Pictou County (Gulf Side)
11	Colchester County to the western shore of Pictou Harbour (inclusive) and including Pictou Island
12	Inclusive of the eastern shore of Pictou Harbour to the Antigonish County
13	Antigonish County (all)
14	Auld's Cove
45	New Brunswick border (Northumberland Strait) to Pugwash point (inclusive)
46	Pugwash point (exclusive) to Colchester County

Gulf New Brunswick Statistical District	Geographical Boundary
63	Restigouche County (all)
64	Restigouche County to Bass River (inclusive)
65	Bass River (exclusive) to Pokesudie Island (inclusive)
66	Shippegan and Miscou Islands (inclusive)
67	Pokesudie Island (exclusive) to PokemoucheGully (inclusive)
68	Pokemouche Gully (exclusive) to Northumberland County
70	Gloucester County to Grand Down Island (inclusive)near Barryville
71	Grand Down Island (exclusive) to Morrissy Bridge on the north side of the Miramichi River and from Morrissy Bridge to Point au Carr (inclusive) on the south side of the Miramichi River
72	Morrissy Bridge to Red Bank (inclusive) on the north west Miramichi and from Morrissy Bridge to Quarryville (inclusive) on the south west Miramichi River

Appendix 3 (continued)

Gulf New Brunswick Statistical District, continued	**Geographical Boundary**
73	Point au Carr (exclusive) to Kent County
75	Northumberland County to the south side of the St. Louis River (exclusive)
76	South side of the St. Louis River (inclusive) to Chockpish River (inclusive)
77	South side of Chockpish River (exclusive) to Westmorland County
78	Kent county to Lower Cape Bald (inclusive)
80	Lower Cape Bald (exclusive) to Nova Scotia boundary on the Northumberland Strait side

Prince Edward Island Statistical District	**Geographical Boundary**
82	Baptist (inclusive) to North Point (exclusive)
83	Percival River to Queens County Line at Victoria Harbour
85	Prince County to the western outskirts of Charlottetown, Northumberland Strait side
86	East Charlottetown (Southport) to Kings County Line (Little Sands) exclusive
87	All of Kings County south of a line from the coast at the south side of Boughton Bay to a line between Queens and Kings Counties
88	Kings County Line (Savage Harbour) inclusive to north side of Boughton River
92	North Point (inclusive) to Cavendish Inlet
93	Foxley Bay exclusive to Queens County Line
95	Prince County Line to Brackley Beach inclusive
96	Brackley Beach exclusive to Kings County Line (Savage Harbour) exclusive

Appendix 4

Value (in thousands of dollars) **of Mussel Exports**[1] **by Destination, Maritimes - 1997 to 2001**

	1997	1998	1999	2000	2001
LIVE, fresh or chilled	11 186	12 759	13 658	18 731	21 245
FROZEN, salted, dried or in brine	26	177	360	305	159
UNITED STATES	11 213	12 936	14 018	19 036	21 404
LIVE, fresh or chilled	-	-	-	142	261
FROZEN, salted, dried or in brine	-	-	69	254	817
JAPAN	0	0	69	397	1 078
LIVE, fresh or chilled	-	186	573	97	-
FROZEN, salted, dried or in brine	-	-	-	-	-
FRANCE[2]	0	186	573	97	0
LIVE, fresh or chilled	11	-	-	-	-
FROZEN, salted, dried or in brine	-	-	-	-	-
BELGIUM	11	0	0	0	0
LIVE, fresh or chilled	-	-	-	-	-
FROZEN, salted, dried or in brine	-	-	-	-	4
HONG KONG	0	0	0	0	4
LIVE, fresh or chilled	-	-	-	-	-
FROZEN, salted, dried or in brine	-	-	45	-	-
ISRAEL	0	0	45	0	0
LIVE, fresh or chilled	**11 198**	**12 945**	**14 232**	**18 970**	**21 506**
FROZEN, salted, dried or in brine	**26**	**177**	**474**	**559**	**981**
Total PEI	**11 224**	**13 122**	**14 706**	**19 529**	**22 486**
LIVE, fresh or chilled	704	595	43	119	92
FROZEN, salted, dried or in brine	69	351	199	262	-
UNITED STATES	773	946	242	381	92
LIVE, fresh or chilled	-	-	-	-	60
FROZEN, salted, dried or in brine	-	7	262	202	306
JAPAN	0	7	262	202	366
LIVE, fresh or chilled	**704**	**595**	**43**	**119**	**152**
FROZEN, salted, dried or in brine	**69**	**358**	**461**	**464**	**306**
Total NB	**773**	**953**	**504**	**584**	**458**
LIVE, fresh or chilled	142	411	512	457	600
FROZEN, salted, dried or in brine	5	-	8	126	-
UNITED STATES	147	411	520	583	600
LIVE, fresh or chilled	-	-	-	147	-
FROZEN, salted, dried or in brine	-	-	127	642	220
JAPAN	0	0	127	789	220
LIVE, fresh or chilled	-	-	-	-	-
FROZEN, salted, dried or in brine	-	-	-	-	13
FRANCE[2]	0	0	0	0	13
LIVE, fresh or chilled	-	-	-	-	18
FROZEN, salted, dried or in brine	-	-	-	-	-
BELGIUM	0	0	0	0	18
LIVE, fresh or chilled	-	-	35	-	-
FROZEN, salted, dried or in brine	-	-	2	-	-
UNITED KINGDOM	0	0	37	0	0
LIVE, fresh or chilled	-	-	-	-	-
FROZEN, salted, dried or in brine	-	-	-	-	12
ISRAEL	0	0	0	0	12
LIVE, fresh or chilled	2	-	-	-	-
FROZEN, salted, dried or in brine	-	-	-	-	-
SINGAPORE	2	0	0	0	0
LIVE, fresh or chilled	**144**	**411**	**547**	**605**	**618**
FROZEN, salted, dried or in brine	**5**	**0**	**137**	**768**	**245**
Total NS	**149**	**411**	**684**	**1 372**	**863**
LIVE, fresh or chilled	**12 046**	**13 951**	**14 822**	**19 694**	**22 275**
FROZEN, salted, dried or in brine	**101**	**536**	**1 071**	**1 791**	**1 532**
TOTAL MARITIMES	**12 146**	**14 486**	**15 893**	**21 486**	**23 808**

Notes: [1]Only Domestic Exports are included. This consist of the exports of all goods grown, produced, extracted or manufactured in the country, leaving the country for a foreign destination. Exports of imported merchandise which has been substantially enhanced in value are also included. Exports leaving one province does not necessarily mean that these products were captured or processed in that province.

[2]Includes Monaco and French Antilles.

Appendix 5 (a)

Canadian Mussel Export[1] Values (in dollars) by Destination, Maritimes - 1992 to 1994

1992

Destination	PEI		NB		NS		TOTAL	
	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
United States	$ 1 255 004	62,6%	$ 13 559	100,0%	$ 247 584	95,3%	**$ 1 516 147**	**66,5%**
France[2]	$ 20 619	1,0%	-	-	-	-	**$ 20 619**	**0,9%**
Belgium	$ 430 261	21,5%	-	-	$ 840	0,3%	**$ 431 101**	**18,9%**
Netherlands	$ 40 300	2,0%	-	-	-	-	**$ 40 300**	**1,8%**
Luxembourg	$ 255 580	12,7%	-	-	$ 10 662	4,1%	**$ 266 242**	**11,7%**
Greece	$ 3 150	0,2%	-	-	-	-	**$ 3 150**	**0,1%**
St.Pierre-Miquelon	-	0,0%	-	-	$ 550	0,2%	**$ 550**	**0,0%**
Switzerland	-	0,0%	-	-	$ 211	0,1%	**$ 211**	**0,0%**
TOTAL	**$ 2 004 914**	100%	**$ 13 559**	100%	**$ 259 847**	100%	**$ 2 278 320**	**100%**

1993

Destination	PEI		NB		NS		TOTAL	
	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
United States	$ 2 524 980	94,5%	$ 13 642	100,0%	$ 147 260	98,0%	**$ 2 685 882**	**94,7%**
France[2]	$ 1 463	0,1%	-	-	-	-	**$ 1 463**	**0,1%**
Belgium	$ 139 997	5,2%	-	-	-	-	**$ 139 997**	**4,9%**
Netherlands	-	-	-	-	$ 2 275	1,5%	**$ 2 275**	**0,1%**
Luxembourg	$ 5 370	0,2%	-	-	-	-	**$ 5 370**	**0,2%**
United Kingdom	-	-	-	-	$ 675	0,4%	**$ 675**	**0,0%**
TOTAL	**$ 2 671 810**	100%	**$ 13 642**	100%	**$ 150 210**	100%	**$ 2 835 662**	**100%**

1994

Destination	PEI		NB		NS		TOTAL	
	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
United States	$ 3 962 899	96,8%	$ 13 892	100,0%	$ 171 700	95,7%	**$ 4 148 491**	**96,8%**
Japan	-	-	-	-	$ 7 721	0,04	**$ 7 721**	**0,2%**
Belgium	$ 104 136	2,5%	-	-	-	-	**$ 104 136**	**2,4%**
Netherlands	$ 25 995	0,6%	-	-	-	-	**$ 25 995**	**0,6%**
TOTAL	**$ 4 093 030**	100%	**$ 13 892**	100%	**$ 179 421**	100%	**$ 4 286 343**	**100%**

Notes: [1]Only Domestic Exports are included. This consist of the exports of all goods grown, produced, extracted or manufactured in the country, leaving the country for a foreign destination. Exports of imported merchandise which has been substantially enhanced in value are also included. Exports leaving one province does not necessarily mean that these products were captured or processed in that province.

[2]Includes Monaco and French Antilles.

Appendix 5 (b)

Canadian Mussel Export[1] Values (in dollars) by Destination, Maritimes - 1995 to 1997

1995

Destination	PEI		NB		NS		TOTAL	
	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
United States	$ 6 736 760	100,0%	$ 222 186	90,7%	$ 87 457	73,0%	**$ 7 046 403**	**99,2%**
Japan	-	-	-	-	$ 30 098	25,1%	**$ 30 098**	**0,4%**
Cuba	-	-	$ 22 684	9,3%	-	-	**$ 22 684**	**0,3%**
Belgium	$ 3 173	0,0%	-	-	-	-	**$ 3 173**	**0,0%**
Netherlands	-	-	-	-	$ 2 310	1,9%	**$ 2 310**	**0,0%**
TOTAL	**$ 6 739 933**	100%	**$ 244 870**	100%	**$ 119 865**	100%	**$ 7 104 668**	**100%**

1996

Destination	PEI		NB		NS		TOTAL	
	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
United States	$ 8 671 420	100,0%	$ 94 450	98,0%	$ 31 755	100,0%	**$ 8 797 625**	**100,0%**
Israel	-	-	$ 1 943	2,0%	-	-	**$ 1 943**	**0,0%**
TOTAL	**$ 8 671 420**	100%	**$ 96 393**	100%	**$ 31 755**	100%	**$ 8 799 568**	**100%**

1997

Destination	PEI		NB		NS		TOTAL	
	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
United States	$ 11 212 761	99,9%	$ 772 637	100,0%	$ 147 057	98,4%	**$ 12 132 455**	**99,9%**
Belgium	$ 11 385	0,1%	-	-	-	-	**$ 11 385**	**0,1%**
Singapore	-	-	-	-	$ 2 339	1,6%	**$ 2 339**	**0,0%**
TOTAL	**$ 11 224 146**	100%	**$ 772 637**	100%	**$ 149 396**	100%	**$ 12 146 179**	**100%**

Notes: [1]Only Domestic Exports are included. This consist of the exports of all goods grown, produced, extracted or manufactured in the country, leaving the country for a foreign destination. Exports of imported merchandise which has been substantially enhanced in value are also included.

Exports leaving one province does not necessarily mean that these products were captured or processed in that province.

Appendix 5 (c)

Canadian Mussel Export[1] Values (in dollars) by Destination, Maritimes - 1998 to 2001

1998

Destination	PEI		NB		NS		TOTAL	
	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
United States	$ 12 935 812	98,6%	$ 946 404	99,3%	$ 410 956	100,0%	**$ 14 293 172**	**98,7%**
France[2]	$ 186 097	1,4%	-	-	-	-	**$ 186 097**	**1,3%**
Japan	-	-	$ 7 013	0,7%	-	-	**$ 7 013**	**0,0%**
TOTAL	**$ 13 121 909**	100%	**$ 953 417**	100%	**$ 410 956**	100%	**$ 14 486 282**	**100%**

1999

Destination	PEI		NB		NS		TOTAL	
	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
United States	$ 14 018 460	95,3%	$ 241 527	48,0%	$ 520 316	76,1%	**$ 14 780 303**	**93,0%**
France[2]	$ 573 335	3,9%	-	-	-	-	**$ 573 335**	**3,6%**
Japan	$ 69 174	0,5%	$ 261 980	52,0%	$ 126 542	18,5%	**$ 457 696**	**2,9%**
Israel	$ 44 562	0,3%	-	-	-	-	**$ 44 562**	**0,3%**
United Kingdom	-	-	-	-	$ 36 912	5,4%	**$ 36 912**	**0,2%**
TOTAL	**$ 14 705 531**	100%	**$ 503 507**	100%	**$ 683 770**	100%	**$ 15 892 808**	**100%**

2000

Destination	PEI		NB		NS		TOTAL	
	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
United States	$ 19 036 052	97,5%	$ 381 279	65,3%	$ 583 417	42,5%	**$ 20 000 748**	**93,1%**
Japan	$ 396 693	2,0%	$ 202 422	34,7%	$ 789 043	57,5%	**$ 1 388 158**	**6,5%**
France[2]	$ 96 648	0,5%	-	-	-	-	**$ 96 648**	**0,4%**
TOTAL	**$ 19 529 393**	100%	**$ 583 701**	100%	**$ 1 372 460**	100%	**$ 21 485 554**	**100%**

2001

Destination	PEI		NB		NS		TOTAL	
	Value	% of Total	Value	% of Total	Value	% of Total	Value	% of Total
United States	$ 21 403 890	95,2%	$ 91 564	20,0%	$ 599 632	69,5%	**$ 22 095 086**	**92,8%**
Japan	$ 1 077 832	4,8%	$ 366 471	80,0%	$ 219 717	25,5%	**$ 1 664 020**	**7,0%**
Belgium	-	-	-	-	$ 18 330	2,1%	**$ 18 330**	**0,1%**
France[2]	-	-	-	-	$ 13 371	1,5%	**$ 13 371**	**0,1%**
Israel	-	-	-	-	$ 12 243	1,4%	**$ 12 243**	**0,1%**
Hong Kong	$ 4 463	0,0%	-	-	-	-	**$ 4 463**	**0,0%**
TOTAL	**$ 22 486 185**	100%	**$ 458 035**	100%	**$ 863 293**	100%	**$ 23 807 513**	**100%**

Notes: [1]Only Domestic Exports are included. This consist of the exports of all goods grown, produced, extracted or manufactured in the country, leaving the country for a foreign destination. Exports of imported merchandise which has been substantially enhanced in value are also included. Exports leaving one province does not necessarily mean that these products were captured or processed in that province. [2]Includes Monaco and French Antilles.

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