6.0 BC AQUACULTURE INDUSTRY

Aquaculture is the husbandry or raising of fish and shellfish. In 2002, there were 576 licensed marine aquaculture farms (121 finfish, 455 shellfish), mostly on Crown Land tenures covering about 3,918 hectares (1,191 finfish, 2,727 shellfish).

This section builds on the aquaculture profile of Section 2.3, describes farm-level industry performance, and identifies business and competitiveness issues for aquaculture. Competitiveness analysis for any industry ultimately focuses on production levels, costs of production, and prices or market returns. The ideal situation obviously is high production, low unit costs, and high unit prices as described below (the "wishlist" is just as applicable to poultry and many other types of farming).

Desirable Attributes of Aquaculture Species

- closed life cycle
- low juvenile cost
- low FCR (feed conversion ratio)
- low feed cost
- can farm at high density
- fast growing
- good processing yield
- disease resistant
- can stand handling well
- well-known
- high price

Source: Bjorn Myrseth "New Species, Niches and Diversification", Marine Farms ASA, Bergen, Norway 2001)

The BC Ministry of Aquaculture, Food and Fisheries recently sponsored a farmed salmon industry survey of competitiveness, research and development (R&D), and public policy issues (see Exhibit 19).

6.1 Markets

Farmgate values were $289 million for finfish and $15 million for shellfish in 2002.

In 2002 the BC farmed salmon industry produced 85,400 tonnes round weight of salmon – 72,800 tonnes of Atlantics, 10,400 tonnes of chinook, and 2,200 tonnes of coho. Farmed shellfish production for 2002 amounted to 8,800 tonnes round weight – 7,200 tonnes of oysters, 1,500 tonnes of clams, and 100 tonnes of scallops and other shellfish. The 2002 farmgate values for finfish and shellfish totalled $289 million and $15 million, respectively.

6.1.1 Domestic and Export Markets

By regulation, all BC farmed salmon and farmed bivalve shellfish must go through a federally registered processing plant. This applies even for product sold within the province. Accordingly, there are no direct farm sales to buyers. The market analysis of processed farmed salmon and shellfish is presented in Section 7 (Seafood Processing). This section concentrates on farm level activity only.

Exhibit 19: A Competitiveness Survey of the BC Salmon Farming Industry

Background. BC is the world's fourth largest farmed salmon producing region after Norway, Chile, and the United Kingdom and accounts for about 5% of total world production. A survey of the BC industry was conducted to identify: 1) areas where it is not competitive; 2) industry research and development priorities, and 3) suggested priorities for public policy. Nine farming companies responded to the survey, representing more than 95% of total BC production. Five of the companies also operate in other regions of the world.

Competitiveness. Costs of production drive competitiveness, since salmon markets are increasingly becoming commodity markets where individual suppliers are price-takers. Using BC as a base index for comparison, companies operating in other parts of the world ranked regions by relative costs of production as follows:

British Columbia	100.0
New Brunswick	106.5
Norway	95.5
United Kingdom	95.3
Chile	86.8

BC costs are higher than those in all the other regions except New Brunswick. (New Brunswick producers receive slightly higher prices.) This is due to the remoteness of many provincial sites; the lack of economies of scale in smolt production; inadequate access to fast-growing, low-maturing stocks; and regulatory costs. Chile is the world's low-cost producer, due to low smolt, feed, labour, and capital costs.

BC producers ranked proximity to the US and the (until 2003) favourable Canada/US exchange rate highest among the business factors contributing to competitiveness. Availability of professional services was also seen as an advantage. Inhibiting business factors were regulatory issues and costs related to tenure applications, the poor public image of aquaculture, and First Nations treaty negotiations. However, business relationships with First Nations were viewed favourably.

R&D Priorities. The highest-ranking R&D priority was fish health, followed by breeding programs and alternative feeds. The lowest rankings were for research on wild-farmed salmon interactions and, somewhat surprisingly, development of new species.

Suggested Public Policy Priorities. Industry identified improved timelines for application approvals as the highest policy priority, receiving the maximum score possible. Federal-provincial harmonization of the tenure application process also ranked very high. Financial assistance programs and training were given a lower priority. Industry saw improved linkages between wild and farmed salmon sectors as an initiative that the provincial government could promote to improve competitiveness.

Conclusions. BC is a high-cost producer of farmed salmon. Reducing costs of production is imperative for industry survival. Cost reduction is dependent on access to new sites and a streamlined regulatory process for both freshwater and saltwater production phases. The industry needs to expand production and tap economies of scale. It currently suffers from a poor public image that, in turn, inhibits regulatory reform.

Source:PriceWaterhouse Coopers, "A Competitiveness Survey of the British Columbia Salmon Farming Industry", Prepared for MAFF, May 2003

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End Products

The main farmed salmon products are fresh-gutted whole fish and "value-added" portions, filets, and steaks. About 70% of the raw fish by weight is sold as fresh dressed.

Two main products are derived from farmed oysters: shucked oysters sold by weight, and whole (live) oysters, destined for the half-shell market, sold by the dozen. In 2002 the total farmgate production by weight was divided roughly equally between these two raw oyster markets. Clams are sold in shell by weight.

Geographic Distribution of Sales

The US West Coast is the primary market for BC farmed salmon, oysters, and clams.

The bulk of BC farmed salmon is sold in the US, particularly West Coast markets, with some product going to Japan. The domestic Canadian market comprises approximately 15% of total farmed salmon sales (10% to BC and 5% to the rest of Canada). About half of BC oysters and over three-quarters of BC farmed clams are exported, again primarily to the US West Coast.

Market Cooperation in the Value Chain

The BC farmed salmon industry, like other food sectors, does have substantial communication and cooperation with other agents farther up the value chain. For example, most farmed salmon is pre-sold before it leaves the farm site for slaughter. The industry tailors its production and deliveries (amounts, timing, fish size, etc.) to meet the needs of the buyer of the processed product.

Cooperation up the value chain is common in salmon farming, but much less so in shellfish farming.

The situation is different for farmed oysters and clams, an industry comprised of much smaller producers. There is substantial mistrust and a lack of cooperation between farm-level producers and processors/ marketers. Often oyster and clam growers will harvest their product and then look for a buyer. In doing so, they run the risk of not meeting buyer specifications, putting product on the market at times of oversupply, and reducing their bargaining power in price negotiations. There is much less marketing expertise and savvy in the BC farmed shellfish sector than the farmed salmon counterpart.

6.1.2 Prices Received

Exhibit 20 displays BC farmgate prices for Atlantic and chinook salmon and for farmed oysters and clams dating from the mid-1980s in $ per kilogram round.

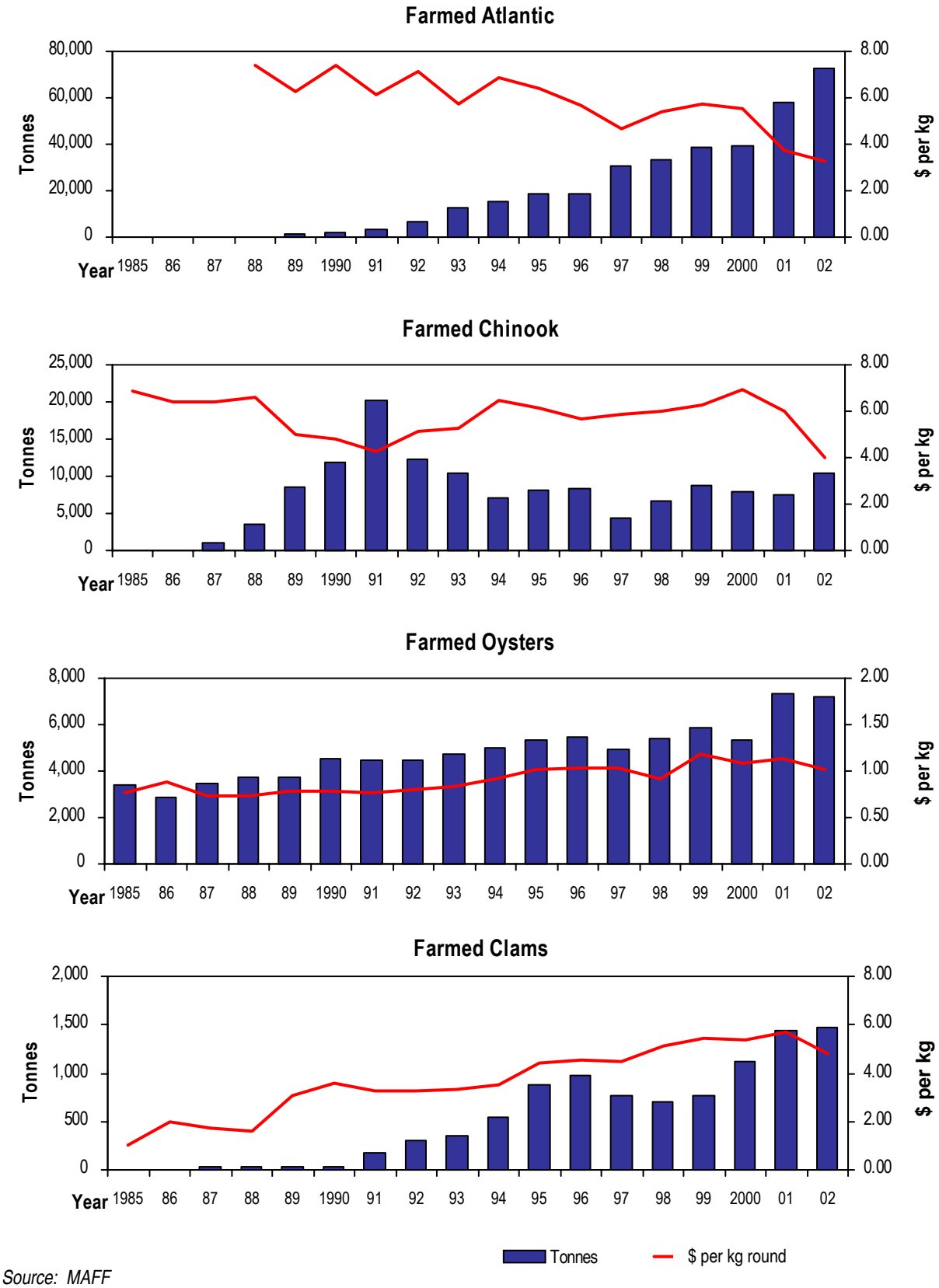
Farmed Salmon

BC farmed salmon, like farmed salmon from Norway and elsewhere, began as a novel, high-priced product. As costs of production fell, the market expanded and farmed salmon became a mass-market protein.

Farmed salmon prices have fallen significantly over the past two decades due to increased supply.

In the latter half of the 1980s, BC farmed Atlantics sold for $6 to $7 or more per kilogram round at the farmgate. By 2002, their average price had declined to $3.27 per kg. While less expensive than Atlantics in the late 1980s, farmed chinook experienced a smaller price decline over time. In 2002 chinook fetched $4.02 per kg, higher than the farmed Atlantic price. The dramatic price declines for farmed salmon since 2000 reflect vastly increased supplies from Chile and other producing countries.

Exhibit 20: BC Aquaculture Production and Farm Gate Prices by Species



Source: MAFF

Farmed Shellfish

Oyster prices were about $0.75 per kg in the late 1980s, increased by a third in the early 1990s, and has ranged from $1.00 to $1.10 per kg since 1995. Prices have been stagnant due to the industry growth in Washington State, a major competitor that produces more than five times BC's oyster production and is closer to the West Coast US market.

Prices have tripled for clams, but have levelled off for oysters because of competition.

In contrast, the price of BC farmed clams has tripled since the late 1980s. The 2002 price was $4.78 per kg, a decline of close to a dollar from 2001 levels. BC clams face less competition from Washington State. Prices for clams are generally strong.

With export sales denominated in US currency, prices for both farmed salmon and farmed shellfish have been hurt by the rising Canadian dollar.

6.1.3 Product Quality and Differentiation

Quality is high for farmed salmon, but less consistent for farmed shellfish.

BC consistently produces high-quality farmed salmon from its cold pristine waters. BC farmed oysters, clams, and scallops also have a very good reputation, but their quality is less consistent. This reflects the many small shellfish growers and the inability to coordinate farm level production, processing, and marketing.

A food product is difficult to brand without packaging. In the case of farmed salmon, it appears that Stolt Seafarms, with its trademarked Sterling brand, is the only company that brands whole fish (through a gill tag on Atlantics). Other companies will label styro package shipments with their name.

Branding is limited for shellfish, and even more so for farmed salmon.

Half-shell oysters are typically identified by location (e.g., Fanny Bay, Cortes Island, Denman Island) when sold at oyster bars and restaurants. On a limited scale, some companies have marketed half-shell oysters on the basis of product attributes (e.g., Summer Ice, Sinku). Shucked oysters sold by container volume by the processor generally lose their identity within the province (i.e., the oysters are sold as product of BC or Canada).

6.2 Government Policies and Regulations

6.2.1 Aquaculture Regulations and Fees

Authority

Aquaculture faces many different federal and provincial requirements.

The regulatory framework for BC aquaculture is complex. The industry is subject to 52 separate federal and provincial statutes, regulations, policies, and guidelines as well as numerous municipal and regional land use and development regulatory processes. Questions of jurisdiction often arise because aquaculture, as a relatively new industry, is not referenced in the *Constitution Act*, 1867.

To clarify matters of aquaculture jurisdiction, in 1988 the Province of British Columbia and the federal government signed a Memorandum of Understanding (MOU) regarding aquaculture development. The MOU names DFO as the lead federal agency for aquaculture and MAFF as the lead provincial agency.

Exhibit 21: Federal Regulations Affecting Aquaculture

Law / Regulation	Purpose / Description
Agency: Fisheries and Oceans Canada	
Fisheries Act: Fish Health Protection Regulations	Regulates the movement of salmonid eggs and live salmonids between provinces and into Canada to minimize the introduction of diseases named in the regulations
Fisheries Act Habitat Provisions (s.35)	Avoids harmful alteration, disruption or destruction of fish habitat
Fisheries Act: (s.55) of Fisheries General Regulations	Prohibits the placing of fish, without a permit, in waters other than those from which they came; does not apply in all provinces or govern the interprovincial movement of fish
Fisheries Act: Management of Contaminated Fisheries Regulations	Allows for area closures where there is reason to believe fish are contaminated (e.g., closures under the Canadian Shellfish Sanitation Program)
Navigable Waters Protection Act	Ensures safe navigation; trigger for environmental assessments for works including aquaculture installations
Marine Mammals Regulations	Regulates the protection, management and control of fishing for marine mammals
Oceans Act	Implements a national strategy for the management of estuarine, coastal and marine ecosystems in waters that form part of Canada, or in which Canada has sovereign rights under international law
Fisheries Development Act	Allows the ministry to undertake projects for the more efficient exploitation of Canada's fishery resources
Agency: Fisheries and Oceans Canada (administered by Environment Canada)	
Fisheries Act: Deleterious Substances Provisions (s.36)	Prohibits the deposit of a substance deleterious to fish or fish habitat
Agency: Canadian Food Inspection Agency (CFIA)	
Fish Inspection Act: Fish Inspection Regulations	Governs the safety and quality of Canada's fish products
The Feeds Act: Regulations	Controls feeds including those used in aquaculture
The Health of Animals Act	Protects the health of food producing animals
Agency: Canadian Environmental Assessment Agency (CEAA)	
Canadian Environmental Assessment Act	Requires an environmental assessment before specified projects are undertaken on federal land
Agency: Health Canada	
Pest Control Products Act	Regulates the manufacture, importation, labelling, sale and use of pesticides in Canada; registration of pesticides
Food and Drugs Act: Regulations	Approves the use of veterinary drugs in Canada
Agency: Environment Canada	
Canadian Environmental Protection Act, Part VI	Regulates, through a permit system, the disposal at sea of non-contaminated wastes, including fish waste
Migratory Birds Convention Act	Requires permits to frighten migratory birds from aquaculture sites

Through an MOU, DFO, and MAFF share primary regulatory authority.

Under the MOU, the Province issues aquaculture licences and is responsible for overall development and management of the industry. The federal government maintains regulatory authority for conservation and protection of wild fish stocks and habitat with respect to aquaculture, and protection of navigable waters. In addition, outside of the MOU, federal agencies such as the CFIA and Health Canada maintain their regular responsibilities for food and public health and safety. Federal and provincial regulations affecting aquaculture operations are listed in Exhibits 21 and 22, respectively.

Local governments are also involved in aquaculture regulations through powers granted by provincial legislation (i.e., the *Local Government Act*, the *Vancouver Charter*, and the *Islands Trust Act*). For example, local zoning and land use bylaws may restrict types of property use. Local governments may also require development permits, building permits, and/or business licences.

Tenure and Licensing Systems

Land and Water BC reviews and approves applications for Crown land tenure, with referral to DFO.

Most BC shellfish and finfish farms operate on provincial aquatic Crown land. Three types of aquaculture tenures are available from Land and Water BC (LWBC): an investigative permit, a licence of occupation, or a lease. Each application for tenure is investigated on its merits based on information provided by the applicant, other agencies and groups (e.g., First Nations), and field inspections.

LWBC refers all tenure applications to DFO, which is responsible for environmental assessments under the *Canadian Environmental Assessment Act* (CEAA). A CEAA is triggered when a federal approval, such as a *Navigable Waters Protection Act* (NWPA) approval, is needed. Under the NWPA, DFO is obligated to ensure the public's right to navigation and marine safety in navigable waters. In addition, the federal government assesses the impact of proposed sites with respect to effects on aboriginal rights and land claims, migratory birds, and other user groups. DFO also assesses applications for possible harmful alteration, disruption, or destruction (HADD) of fish habitat under section 35 of the *Fisheries Act.*

US West Coast Shellfish Aquaculture

The states of Washington, Oregon, California and Alaska have produced close to 50,000 tonnes of farmed oysters, clams, mussels, scallops and geoducks worth over $Cdn. 100 million in recent years. Oysters represent 90% by weight and 75% by value of the total. Washington State production comprises about 85% of the total weight and value.

Washington State's industry is much bigger than BC's, is subject to state regulation only, operates primarily on private land using beach culture, and is self-sufficient in terms of hatchery seed. Very few deepwater operations exist because shellfish farming in public waters requires a state permit. Apparently, this involves a process that is even more daunting than the federal-provincial regulatory process in BC.

Exhibit 22: Provincial Regulations Affecting Aquaculture

Law / Regulation	Purpose / Description
Agency: Ministry of Agriculture, Food and Fisheries	
Fisheries Act	Provides for licensing and regulatory control of activities associated with commercial fisheries and aquaculture operations; primary concerns are the licensing of: fish processing plants, fish buying establishments, fishers selling their own catch, wild oyster and marine plant harvesting, and aquaculture operations
Aquaculture Regulation	Governs operational aspects of salmon farms, e.g., frequency of net and containment system inspections, predator control, boat operations, dive inspections, anchoring systems, escape prevention/response, harvesting/processing, documentation and record keeping
Fish Inspection Act	Provides the authority to regulate activities concerning the handling, processing, storing, grading, packaging, marking, transporting, marketing and inspection of fish and fish products
Right to Farm Act: Farm Practices Protection	Protects farmers from nuisance claims; prevents local government from enforcing bylaws dealing with noise, odours, etc., from normal farm practices
Animal Disease Control Act	Administered by the Provincial Veterinarian, provides a statutory authority to limit the spread of contagious diseases in animals, including aquatic animals
Veterinary Drug and Medicated Feed Regulation	Regulates manufacture and sale of medicated feed and veterinary drugs
Agency: Land and Water BC (Ministry of Sustainable Resource Management)	
Land Act	Governs the disposition, management and administration of Crown land
Agency: Ministry of Water, Land and Air Protection	
Waste Management Act	Establishes a basic prohibition against the introduction of waste into the environment during the course of an industry or business activity
Finfish Aquaculture Waste Control Regulation	Provides the legal authorization for all finfish farms to discharge waste, without permits, while ensuring that aquaculture wastes are managed in an environmentally sustainable manner
Wildlife Act (esp. s. 37 re: release of fish in non-tidal waters)	Specific responsibilities outlined include establishing and protecting wildlife management and critical wildlife areas; declaring and protecting endangered species; and regulating the import and export of wildlife
Pesticide Control Act	Regulates the application, storage, disposition and transportation of pesticides; specific regulations spell out requirements
Firearms Act	Regulates the transport and discharge of firearms
Agency: Ministry of Sustainable Resource Management	
Environmental Assessment Act	Provides that proposed projects designated as reviewable projects are subject to an environmental assessment
Water Act	Regulates the use of fresh water systems
Agency: Ministry of Health	
Pharmacists, Pharmacy Operations and Drug Scheduling Act	Provides for registering pharmacists, setting standards of practice, and selling and disposing of drugs that are available for health care in the province

Licensing Farm Production and Operations

A provincial aquaculture licence regulates production and operations.

Once a site tenure is approved, the main provincial mechanism for regulating aquaculture production and operations is the aquaculture licence. This licence is issued under authority of the provincial *Fisheries Act* and the associated Aquaculture Regulation and is administered by MAFF. As well, other permits are required, for example a waste discharge permit from the BC Ministry of Water, Land and Air Protection. Farm operators are required to supply to MAFF annual statistical reports that indicate stocking rates, harvest volumes, and sales by species.

Aquaculture operations require a CEAA environmental screening.

DFO is the lead federal agency and oversees the protection of fish habitats. The Department reviews aquaculture applications to ensure the protection of wild fisheries and the marine environment as well as safe marine navigation. Aquaculture operations must undergo an environmental screening (the most basic level of assessment) under the Canadian Environmental Assessment Act. The CEAA process considers environmental and socio-economic impacts and suggests appropriate measures for minimizing or eliminating potential adverse impacts associated with a proposed activity.

For new aquaculture species, DFO authorizes access to wild broodstock and seed. CFIA must inspect and approve processing facilities for all farmed shellfish and salmon. Environment Canada oversees water quality monitoring of shellfish growing sites.

The siting of shellfish farms is conducted through the review and authorization of a Shellfish Management Plan (SMP) by the provincial and federal governments. Required are a shellfish management plan, Crown land tenure, commercial aquaculture licence, and a federal Navigable Waters permit, in addition to a CEAA review, if applicable. LWBC administers Crown lands and respects the riparian rights of waterfront property owners and First Nations interests.

Canadian Shellfish Sanitation Program

The Canadian Shellfish Sanitation Program (CSSP) is a federal program jointly administered by the Canadian Food Inspection Agency (CFIA), the Department of Fisheries and Oceans, and Environment Canada.

The objectives of the program are:

- to ensure that all bivalue molluscan shellfish are harvested from growing areas that meet the approved federal water quality criteria;
- to recognize and remediate pollution sources, and
- to ensure that harvesting, transporting, and processing are done in an approved manner that reduces the possibility of consumer illness due to contaminated or poor quality shellfish.

The CFIA is responsible for the control of handling, storage, transportation, processing, packaging, labelling, shipping certification, and repacking of shellfish (including imports) to protect against contamination and product quality degradation. DFO is responsible for the enforcement of closure regulations and oversees the opening and closing of shellfhish growing areas. DFO also regulates licences, harvesting locations and times, and minimum harvest sizes. Environment Canada is responsible for monitoring water quality in shellfish growing areas and classifies all shellfish growing areas for suitability for shellfish harvesting. A CSSP Manual of Operations provides information on safety policies and procedures throughout shellfish harvesting and processing and is available through the CFIA website (www.inspection.gc.ca).

The CSSP meets the standards and criteria established in the National Shellfish Sanitation Program, a program administered by the USFDA. As a result, Canada, as well as New Zealand and Chile, are the only countries in the world that are presently approved to export live shellfish to the US market.

Fees

Finfish aquaculture operators pay a variety of fees to the provincial government for processing applications and managing tenure agreements as well as rent or the use of Crown Land or foreshore:

- $100 for each lease, licence, or permit requested;
- $25 for a new aquaculture licence application;
- $150 for each successful tenure application (and $50 for a successful investigative permit);
- $100 or $200 for a successful aquaculture licence (depending on size);
- $250 annual rent for an investigative permit;
- $324 to $587 per hectare annual licence rent for intensive areas (with a 50% reduction in extensive areas); and
- $346 to $563 per hectare annual lease rental for intensive areas (with 50% reduction in extensive areas).

Shellfish aquaculture operators pay a variety of fees to the provincial government:

- $500 for a new tenure application (one-time);
- a $4,500 management fee for successful application (one-time);
- $150 for documentation (one-time); and
- an annual rental fee (the minimum is $600 per tenure which many pay).

Growers also pay property taxes to local government or trusts based on BC Assessment property assessments. Growers can also pay for zoning amendments.

6.2.2 Regulatory Issues and Developments

Regulatory uncertainty is a constraint on industry development.

Meeting the numerous regulatory requirements can be complicated, time-consuming, and expensive for industry. The regulatory climate for aquaculture is uncertain, with a lack of coordination between federal and provincial agencies and inconsistencies in regulatory processes. These regulatory issues add costs, reduce net returns and viability, and stifle industry investment, financing and expansion.

Salmon Aquaculture Review

In July 1995 the British Columbia Environmental Assessment Office launched a review of the operation, regulation, and management of salmon aquaculture in BC. Pending the Salmon Aquaculture Review (SAR), there was moratorium on new salmon farming sites.

Released in August 1997, the Salmon Aquaculture Review Final Report found that, in general, the current state of salmon farming in BC presented a low overall risk to the environment, but that much information was lacking on the issues of fish health, environmental impacts, and the impacts of escaped farmed salmon. The report also noted that regulations and standards had often been inconsistently applied and enforced. It presented 49 recommendations designed to address these issues.

Following the Salmon Aquaculture Review, the moratorium on new farm sties was lifted.

The Province subsequently endorsed the recommendations, and has been working with industry on implementation. In September 2002, the moratorium on new salmon farm sites was lifted.

Greater Regulatory Scrutiny

The aquaculture industry has expressed concern that it faces greater federal environmental review and enforcement than other activities, such as bottom-drag fisheries, that also make use of the aquatic environment and can impact fish resources and habitat. The exemption of some sectors from environmental review not only imposes additional costs on the industry, but also leaves it vulnerable to impacts from those activities. For example, increased sewage discharge (and related degradations of water quality) from recreational boating activities or from expanding coastal housing development may result in the closure of aquaculture sites and increase costs for monitoring programs.

Inconsistent DFO Practices

Some DFO Pacific Region operational practices are hindering industry growth.

There are apparent differences in the application of policies and procedures between DFO Pacific Region and the Department's east coast operations. There are also differences in regulatory costs. According to the 2003 Sadar report (Sadar et al. 2003). West Coast CEAA requirements appear to be implemented as instruments for enhancing habitat protection objectives of the *Fisheries Act*. In addition, the provisions of the *Navigable Waters Protection Act* are being used to hinder aquaculture growth. The Sadar report further states that there is a lack of clear understanding of CEAA by some DFO Pacific Region staff, who may "put their own spin" on CEAA-related requirements, creating unjustifiable delays.

Untimely Delays in CEAA Screenings and Approvals

Long environmental assessments hurt the industry.

The aquaculture industry does not dispute the value of environmental assessments but considers DFO to be slow and ineffective in its CEAA screening and approval procedures. Environmental assessment for an individual farm site can take more than two years. The industry's collective view is that the lack of timely approvals stymies its growth, puts individual companies in dire financial straits, and eliminates employment opportunities for economically disadvantaged coastal communities.

Economic Repercussions of Delays in the CEAA Review Process

In early 2003, Marine Harvest closed the multi-million dollar Wolf Creek Hatchery in Port Edward near Prince Rupert. The company had planned for the chinook smolt production from the hatchery to serve several new Central Coast grow-out sites that were undergoing CEAA review. However, DFO delays in reviewing the site applications meant that the company had to cull 300,000 smolts and lay off 13 full-time employees. Lost job opportunities, many to aboriginal people, also occurred at the grow-out sites and at the processing plant on the Central Coast.

DFO itself admits there is a problem. In March 2003 the Minister of Fisheries and Oceans Canada committed the Department to reviewing and processing 16 high priority farmed salmon tenure applications within six months. Some of these applications had been under review for more than two years. By late September 2003, only five applications(all relocations) had been processed and approved. It appears that DFO does not have the dedicated resources to meet its commitments and responsibilities for CEAA reviews. (DFO has indicated that it has expanded its Pacific Region CEAA staffing several-fold since June 2003 in an attempt to reduce the backlog of applications.)

An inventory of pre-screened Crown land could alleviate CEAA delays.

Some of the delay could be obviated through the establishment of an inventory of pre-screened Crown land to meet industry's immediate needs. Not only could such an inventory identify marine foreshore and deepwater sites, but it could also include upland parcels that have the capability to support tank farm operations and freshwater lakes to support non-anadromous farming and smolt production.

Many existing tenures will be up for renewal in the next three years and industry is apprehensive about how the renewals will be handled under CEAA. In particular, aquaculturists wonder if they will be able to farm during the tenure renewal process.

Access to Shellfish Broodstock

Access to shellfish broodstock is tightly controlled.

Federal policy, rather than regulation, controls access to wild shellfish species. The exception is oysters which are a provincial responsibility. In general, DFO fisheries managers do not allow for the collection of broodstock or juveniles (seedstock) for culture operations. Access may be granted under research permits but generally any species proposed for culture requires access to hatchery-produced seed.

The potential commercial culture of species such as northern abalone is very tightly controlled under Endangered Species legislation. Currently, hatchery, nursery, and culture of abalone are allowed only under special agreement/contract and access to broodstock controlled by permit and any other possession of abalone illegal.

For new shellfish species, CFIA must be assured that the product will not have PSP (paralytic shellfish poison or "red tide") and other biotoxins.

Codes of Practice

The industry has moved to implement best practices.

In June 2001 the BC Salmon Farmers Association (BCSFA) released a Code of Practice containing best practices in a number of areas including waste material, fish mortalities and blood water disposition, fish health, and therapeutants. This had been a recommendation in the SAR report. BCSFA is currently updating the Code.

The provincial government, with industry support, is in the final stages of adopting a Code of Practice for the farmed shellfish sector (the BC Shellfish Growers Association or BCSGA adopted an Environmental Management System Code of Practice in 2001). The BCSGA and the BCSFA codes will together raise standards and performance, comply with applicable laws and regulations, and ensure farming practices meet objectives for environmental sustainability.

Farm Practice Protection Act

In October 2003 the provincial government amended the *Farm Practice Protection (Right to Farm) Act* and the *Local Government Act* to prevent local governments from limiting farming operations, including aquaculture, in ways that violate the intent of right-to-farm

legislation. The amendments clarify the law by allowing the province to designate Crown Land suitable for aquaculture as a farming area before aquaculture licences are issued.

Smart Regulation

The federal government is developing a smart regulation strategy.

The 2002 federal throne speech committed the Canadian government to moving forward with a smart regulation strategy. Smart regulation means capturing opportunities by rethinking what and how the federal government regulates.

To help pursue the strategy, an External Advisory Committee on Smart Regulation (EACSR) has been established. Its mandate will be to recommend areas where government needs to improve, expand, or possibly redesign its regulatory approach. The research phase underway will focus on streamlining existing regulations, building federal regulatory capacity, and synchronising regulations between provinces and the federal government as well as between federal departments.

CEAA Amendments

In an effort to deliver environmental assessments in a more certain, predictable and timely manner, the federal government proposed CEAA amendments. Bill C-9, An Act to amend the Canadian Environmental Assessment Act, received Royal Assent on June 11, 2003, and entered legislation in October 2003.

Under the Bill, all assessments will require a federal coordinator to help federal departments and agencies work together and with other jurisdictions. The new legislation will increase opportunities for public and First Nations involvement in the assessment process, and will focus efforts on projects more likely to have significant adverse environmental impacts.

How recent CEAA improvements will affect aquaculture is uncertain.

The effect of the legislation on environmental assessments of aquaculture remains to be seen. While industry welcomes more timely assessment decisions, it is unknown if aquaculture projects will see greater or lesser scrutiny overall.

6.2.3 Incentive Programs and Subsidies

There are no specialized assistance programs for salmon and shellfish growers, such as grants, low-interest loans or tax holidays. In 1998, the federal government created the Office for the Commissioner of Aquaculture Development (OCAD), an agency and industry development program that reports to the Minister of Fisheries and Oceans. OCAD is scheduled to terminate at the end of March 2004.

6.2.4 Federal-Provincial Cooperation

The1988 federal-provincial MOU clarified matters of federal and provincial aquaculture jurisdiction. In practice, however, coordination and cooperation remains difficult. LWBC places a priority on authorizing aquaculture applications, but this does not appear to be the case for federal agencies.

Harmonization of federal-provincial regulatory processes is essential for industry stability.

Many industry observers consider DFO Pacific Region to have an adversarial approach to aquaculture, and to conduct environmental assessments that are neither fair nor impartial. Harmonization of federal-provincial aquaculture approvals and regulations is essential for industry stability. The current lack of cooperation is clearly adding to the challenges both in the tenure application process and in subsequent farming operations.

6.2.5 Aboriginal Issues

Several First Nations are active in aquaculture in BC.

The Kyuquot, Ahousaht, and Kitasoo First Nations are actively involved in salmon farming through joint ventures. The Kitasoo First Nation also owns and operates a processing plant at Klemtu. Its interests in the salmon farming and processing operations are managed through an economic development corporation that is fully arms length from the Band Council. The Band sees the separation of business and politics as a key ingredient to success (see Case Study 6).

Several First Nations are also active in oyster and clam culture, including the Sliammon First Nation which has productive oyster tenures in Okeover Inlet. Nonetheless, as a general rule, aboriginal participation in aquaculture is much lower than the aboriginal participation in fish harvesting sector. Several studies have noted that there is not a good fit between salmon farming and aboriginal culture, with many First Nations vehemently opposed to salmon farming.

Aboriginal joint ventures are a promising economic development opportunity.

However, finfish and shellfish aquaculture is one of the few economic development opportunities available to aboriginal people that does not require relocation from their home communities Senior government agencies, such as Aboriginal Business Canada and Human Resource Development Canada (HRDC), are beginning to see the strong linkage and business potential between aquaculture and aboriginal economic development. Substantial financial support is likely available for sound business plans and human resource strategies that strive to increase aboriginal participation in aquaculture. Capacity building, at both the entrepreneurial and workforce level, is key.

Despite this promising opportunity, the uncertainty surrounding aboriginal land claims tends to temper investment and business planning in the aquaculture sector. In addition, the Province has an obligation to consult with First Nations that may have traditional use of the foreshore in the Crown Lands tenure application.

It is likely that most new aquaculture operations, and especially finfish operations, will involve joint venture partnerships with aboriginal organizations. The success of the partnerships to date is demonstrable to both the aboriginal people and private sector investors.

6.3 Human Resources

6.3.1 Labour Utilization and Wages

Shellfish farming employment is more seasonal and part-time than salmon farming employment.

Since salmon farming occurs year-round, most of its jobs are full-time and full-year. Shellfish farming, on the other hand, is more seasonal and occasional because shellfish do not require feeding and the timing of beach harvests depends on tides. According to a farm-level employment survey conducted by MAFF for 2000, more than one-third of shellfish employment was part-time but only 8% of finfish employment was part-time. However, as the shellfish industry adopts greater technological innovation, more full-time employment opportunities should occur.

Case Study 6: Kitasoo Aqua Farms and Seafoods

Issue

The community of Klemtu on BC's central coast is home to the Kitasoo/Xai'xais First Nation. With the severe downturn of the wild salmon fishery in the mid-1980s, the Kitasoo people recognized the need to diversify their economy. To achieve diversification, they built a modern seafood processing plant and elected to pursue salmon farming as an alternative to their traditional fishery. From its inception, Kitasoo Aqua Farms Ltd. struggled with economic challenges: in 1993 the farm was forced to suspend operations due to low fish prices and a rapidly changing industry. In addition, there has been an ongoing controversy over local salmon farming. Protests by an environmental group and the Nuxalk First Nation have halted the transportation of farmed salmon through the Bella Coola Valley.

Response

To sustain its operation, Kitasoo Aqua Farms sought a multinational partner with a large capital base and investment potential. In 1997 it began negotiations with Nutreco Canada (Marine Harvest Canada), one of the largest salmon and salmon-feed producing companies in the world. The two companies signed an agreement in late 1998 whereby the Kitasoo people hold the tenures and provide the labour for two fish farms, while Nutreco owns the equipment. This agreement has created an additional 17 full-time equivalent jobs for the Kitasoo Band worth $600,000 in annual wages.

The joint venture also involves Kitasoo Seafoods Ltd., which operates the processing plant and is managed by the Kitasoo Development Corporation, an agency at arms length from the Band Council. Since 1985 the company has processed frozen geoducks, sea cucumber, red urchin, wild salmon (fresh and frozen), salmon roe, and herring roe on kelp. In September 2000, it started processing farmed salmon. Kitasoo Seafoods employs 30 FTEs when processing at full operation, contributing about $1 million in wages to the local economy in 2002.

Results

The processing plant and fish farms have been an economic boon to the community. During 2002, more salmon was harvested and processed each week than was produced in an entire year at the pre-partnership farm. Of the 100 Kitasoo employed full-time, 47 work in salmon farming. The partnership has also brought greater capacity to Klemtu: Nutreco, the Kitasoo and North Island College deliver a customized and accredited six-month aquaculture training program in the community. Twelve Kitasoo people graduated from the program and are now working on the salmon farms. Band members are given opportunities and training to rise to management positions at the farms. Young Kitasoo workers are developing increased self-esteem, for the first time feeling that they have options for the future, as many of the skills they acquire will be transferable to other jobs.

Lessons Learned

The Kitasoo ventures are success stories in partnering and economic diversification. The processing plant is capable of handling a variety of seafood products and made a strategic investment in intensive training to bring its crew up to competitive efficiencies of operation. The Kitasoo people were able to acquire the necessary investment capital to keep their farming operations, while maintaining local ownership, jobs, training and other benefits from the salmon farms. To protect traditional food harvesting, they also consulted intensively in the community on siting the farms, addressed the issue of fish waste, and launched their own program of environment monitoring. Transportation remains a continuing challenge, with talks underway with the BC Ferries Corporation to better service community and business needs.

Aquaculture currently provides around 2,400 jobs.

In 2002 the labour profile of the aquaculture industry (hatchery plus growout) was as follows:

	Jobs	Employment (PYs)	Wages & Benefits ($ millions)
Finfish*	1,600	1,410	50
Shellfish*	800	320	8
Total	2,400	1,730	58

** Excludes processing, transport, selling, and general and administration functions covered under processing (Section 7).*

The above figures are only estimates produced by the authors of this report, based on interviews and unpublished research. The Canadian Aquaculture Industry Alliance (CAIA) has acknowledged that the lack of good employment data has impeded its ability to undertake human resource strategies and to demonstrate the industry's economic importance to the public (CAIA 2003).

Farmed Salmon Jobs and Wages

Owners of farmed salmon operations are generally large corporations operating many sites. These companies employ a professional workforce at the farm site and in the administrative office.

Salmon farm site workers earn $2,000 to $3,000 a month.

A farmed salmon site requires farm and maintenance technicians, a site manager and a fish health technician. Starting salaries for these personnel range from about $2,000 per month for the farm technician to perhaps $3,000 per month for the site manager. Experienced people can be paid one-third more than the base salary. Some remote sites operate rotational shifts of workers who live at the site for extended periods and receive room and board.

The core office staff includes a biologist, maintenance manager, accountant, senior site manager, and operations manager. These positions offer base starting salaries of $3,000 to $4,500 per month. Again, experienced personnel can earn one-third more than the minimum. Payroll burden, or benefits above wages, for field and administrative personnel range from 15% to 20%.

BC is a high-cost region for salmon farming labour.

BC is a relatively high wage-cost region. Wage rates in New Brunswick and Chile, for example, are 20% and 80% lower, respectively.

Farmed Shellfish Jobs and Wages

The majority of shellfish farms are small family-run operations with revenues under $50,000. These operations do not farm shellfish full-time or year-round. Most do not hire labour outside the family except at harvesting time. However, there are a few businesses operating several sites that hire ten or more workers, and that have revenues exceeding $1 million annually.

Shellfish harvesting pays about $2,000 per FTE per month.

Harvesting is labour-intensive, done mainly by farm employees in the case of oysters, and contract harvesters in the case of clams. Monthly wage rates are about $2,000 per FTE, including a 10% payroll burden. Contract clam harvesters are paid about $150 to $200 per day.

6.3.2 Skilled Labour and Training

The aquaculture industry requires a knowledgeable, skilled and stable workforce to compete globally in the food business. There is considerable variation in skill level requirements across the aquaculture workforce, from general labourers to highly skilled professionals, such as veterinarians. However, the trend is towards increasing skill requirements for all occupations.

Skill Requirements and Recruitment

Preoccupied with regulation and access to new sites, BC aquaculturalists have had little time for human resource matters. There are significant labour shortages and recruitment issues, particularly for veterinarians, managers, and technicians. Moreover, animal husbandry and mechanical skills are becoming more important and general labour skills less so at the farm site.

Remote aquaculture operations have a hard time recruiting and keeping workers.

While aquaculture often is considered a natural transition for individuals displaced from the commercial fishery, in many cases this is a misconception. Certain parallels exist between the two sectors with regard to the remoteness and maritime nature of the workplace and, to a lesser degree, the use of materials such as nets and rigging. However, the maturing of the farmed salmon industry and a focus more on growing than harvesting demands workers and technicians with highly developed skills and education in fish health and veterinary science, site management, animal husbandry, and mechanical skills. General labour is less valued.

The industry has experienced serious recruitment and staff turnover problems. The remoteness and spartan facilities at production sites pose a barrier to recruiting and retaining employees. Young people are attracted to urban centres with higher incomes and better amenities.

Labour shortages and high staff turnover increases costs and lowers productivity.

Labour shortages mean that there is significant competition among companies to recruit personnel. In BC, many entry-level employees are recruited from outside the province, in part because better aquaculture training is available on the East Coast. The intensity and breadth of education and training for East Coast diploma graduates cannot be currently matched on the West Coast. Further, there appears to be more industry commitment and lower turnover in the case of eastern recruits. BC's labour shortages and high turnover rates add to costs and reduce productivity.

Fisheries and Marine Institute

The Fisheries and Marine Institute is part of Memorial University in St. Johns, Newfoundland. Its Advanced Diploma of Technology Program is a one-year post-graduate applied program that prepares students for a variety of aquaculture careers. Admission requires completion of a three-year diploma program or four-year degree program. Areas of study include site evaluation, business management and communications, marketing, economics, seafood processing, aquaculture systems operations, fish health, fish nutrition, aquaculture engineering, and fish and shellfish culture.

More education, training and recruitment are critical in BC.

The aquaculture industry must find ways to attract and retain young British Columbians. It needs to be seen as offering promising career options and appropriate education, training and certification programs. Recruitment efforts should target individuals who are interested in working seasonally as well as year-round. Skills upgrading programs are also important to keep up with new technologies and help employees understand new quality and safety standards. While potentially expensive, training can save time and money.

Worker Productivity

Productivity appears to be rising, but varies substantially across operations.

Worker productivity is affected by a myriad of factors including technology and mechanization, worker skill levels and diligence, and scale of operation. Productivy in the aquaculture sector is poorly documented but appears to be increasingly. For example, output per farmed salmon worker has risen by one-third since the early 1990s. There is still a large variation in production per worker per hectare, amounting to fivefold or more in the shellfish industry.

Training

Formal aquaculture worker training is currently limited in BC.

Most aquaculture training currently occurs on-the-job in BC. There is little formal training at off-site institutions, and no industry training standards existing for aquaculture workers.

Aquaculture training in BC is currently offered through North Island College, Malaspina University College, and through company and association on-site training initiatives. North Island College in Campbell River offers a certificate program in Salmon Farm Technician positions. Developed and continuously revised through input from BCSFA member companies, this program provides a source of entry-level wrokers. This program has been offered in remote locations such as Klemtu and Kyuquot, in support of First Nation/Industry partnerships. Courses were also piloted through distance education to workers on-site.

Malaspina University College in Nanaimo offers diploma programs in fisheries and aquaculture technology as well as a Bachelor of Science in fisheries and aquaculture. However, program take-up is not large. Malaspina and UBC also have a one-year diploma program in the management of aquaculture production systems. BCIT offers a range of courses related to fish harvesting, processing, and quality and safety. East Coast training institutions, such as the Marine Institute in St. John's, offer the advantage of accreditation agreements with the partner universities, in this case Memorial University.

Malaspina's Centre for Shellfish Research is currently developing a comprehensive operational and business plan for a BC research and training farm that will be dedicated to shellfish aquaculture.

Several studies have addressed aquaculture training needs (Praxis 2002; CAIA 2003), noting that the range of needed skills may expand in the future as the result of:

- commercialization of new species, such as halibut;
- technological change;
- the complexity of environmental and regulatory issues; and
- the increasing size and sophistication of farms, which require advanced management and administrative skills.

Aquaculture workers need food production and marketing training.

These skills requirements, in turn, may require a different focus for training. In particular, the aquaculture workforce requires food production and marketing skills but existing training is largely fishery-related.

Industry partnerships are essential for workforce investment.

The aquaculture industry must build internal partnerships to help coordinate and drive investment in the labour force. At the same time, the industry's diversity, across regions and products, makes it very difficult to bring people together around shared priorities and needs. Building partnerships within industry, and with federal and provincial agencies and affiliated organizations, will help with program development and delivery. Aquaculture can also learn from the experience of other industries that have faced labour skills shortages.

6.3.3 Management and Labour Environment

Labour-management issues are not a problem in aquaculture.

No BC salmon farms are unionized, but one farmed salmon processing plant has a union. Negotiations over wages, benefits, and working conditions are an individual company matter. There do not appear to be any serious labour-management issues. For the shellfish sector, the owner-operator and family nature of many businesses internalizes such issues to a large extent.

6.4 Investment, Financing, and Capital

6.4.1 Investment Levels

Salmon Farm Level Investment

Current information on the investment base of the BC farmed salmon industry is not available. The first and last formal financial survey of the industry was conducted for the 1993 operating year (ARA, 1994). Some information was updated in the mid-1990s for the Salmon Aquaculture Review (Coopers & Lybrand 1997).

At the national level, some investment information is available from the annual reports of publicly traded companies (e.g., Stolt-Nielsen S.A.). The New Brunswick Salmon Grower's Association has sponsored a financial analysis of provincial operations for 1997 (Doane Raymond and ARA 1998) and 2000 (Stewart 2001).

Total investment in BC salmon farming is in the order of $300 to $400 million (original cost).

Based on the above information and growth in BC salmon farming since the 1990s, the industry's 2002 investment base is estimated to be $300 to $400 million on an original cost basis, or $120 to $180 million on a Net Fixed Assets (NFA) basis (where NFA is original cost less accumulated depreciation). These figures include investments in farms and hatcheries but exclude investments in processing plants (plant investment is addressed in Seafood Processing Section 7).

Shellfish Farm Level Investment

Total investment in BC shellfish farming is around $35 to $70 million (replacement cost).

Current investment per hectare in clam and oyster farming ranges from $25,000 to $50,000, including land tenure. The higher end of the range is applicable to clam culture and deepwater oyster culture. The lower end refers to beach culture of oysters. The total replacement cost of capital investment in shellfish culture is therefore $35 to $70 million for the industry's 1,400 active hectares of tenures, of which only about two-thirds are active.

6.4.2 Viability and Financial Performance

Salmon Farming Viability

2002 was a poor financial year for BC salmon farming.

BC salmon aquaculture had a poor year in 2002. Prices were down about 40% from their 2000 levels and some production was culled due to IHN (Infectious Hematopoietic Necrosis) disease outbreaks. Financial returns to the BC industry, as in other jurisdictions, were substantially lower than in 2000.

> **Lower Prices from Increased World Supply**
>
> The demand/supply balance in the EU market in much of 2000 was more favourable to the salmon farming industry in Europe than it had been for several years, resulting in better market prices… At the end of 2000 and into 2001, however, supplies from Chile, the UK, Ireland, and the Faroe Islands all increased substantially, causing a sharp imbalance in the supply into the market, and this has resulted in sharply reduced prices in all markets. For 2001, prices were some 30% lower in Europe and 40% lower in the US compared to levels in 2000. In 2002, prices in Europe were a further 10% lower than on average in 2001, and in the US market some 10% lower than in 2001.
>
> Stolt Nielsen A.A., *Annual Report 2002*

Shellfish Farming Viability

A recent analysis of BC shellfish aquaculture indicates that in 2002 the industry as a whole earned less than 10% EBITDA on sales and essentially zero cash flow after paying the operator a wage (Salter 2002). This poor financial performance is typical of recent years.

BC shellfish farming should earn around 25% EBITDA.

A reasonable financial target, based on the industry's capital structure, is about 25% EBITDA on sales. Achieving that target will require either a doubling of current production from the existing tenure base or a 50% increase in prices for current production, or some combination of the two. The target is very unlikely to be achieved without fundamental changes in both regulatory and industry practices.

6.4.3 Access to Financing and Equity

There is limited formal information on financing of BC aquaculture operations. In 1995 banks and trust companies held the largest percentage of debt for aquaculture producers and suppliers in Canada (Cormier and Tillapaugh 1998).

Salmon Farming

Access to capital is not a problem for most BC salmon farms.

The majority of BC salmon farming operations are owned by large food production companies, many international in scope. Some are publicly traded. As a result, the industry generally has access to banks and other traditional lending sources for financing and to parent companies and capital markets for equity. Provided that the business fundamentals are strong, financing does not appear to be an issue for salmon aquaculture.

Shellfish Farming

BC shellfish farming companies, in contrast, are much smaller and less sophisticated. Normal financing vehicles include the Farm Credit Corporation (FCC), banks and credit unions. In some cases, private investors supply equity capital. No BC shellfish company is publicly traded.

Lending practices differ by institution. Some consider site productivity and tenure value while others primarily consider cash flow. Typically, 35% to 50% equity is required. The FCC will typically provide financing up to $30,000 for start-up growers, and larger amounts to established operations.

Inadequate business plans and other barriers limit access to financing for shellfish operators.

The authors' discussions with lending agency representatives indicate that many loan applicants do not have a viable business plan. Many prospective plans lack key information, such as to whom the grower intends to sell the product. Other barriers to financing include:

- **Lack of lease transferability.** LWBC issues leases to operators, but the leases cannot be reassigned or transferred without consent from the Crown.
- **Lack of crop insurance.** Crop insurance is prohibitively expensive and so is generally not carried by shellfish farmers. Site-specific risks to shellfish include harvest closures due to bacterial contamination, PSP blooms, predation, natural disasters, theft, and vandalism.
- **Difficulty in obtaining an evaluation.** An expert appraisal, such as a biophysical assessment, is expensive.
- **Inability to achieve economies of scale.** There is a large difference between the hobby farmer (who relies on family labour) and the commercial operator (with employees and capital for investment) in their ability to cultivate multiple species and/or sites.

BC shellfish growers must expand to be competitive.

In short, growers must develop in size and expand production to reap the cost efficiencies necessary for competitiveness, especially given the recent strengthening of the Canadian dollar against the US dollar. (Most costs are denominated in the former, while most sales are denominated in the latter.) More adept marketing skills are also needed.

6.4.4 Technology and Research and Development (R&D)

Both federal and provincial governments sponsor research in aquaculture. AquaNet is a federally funded program that supports aquaculture research initiatives across Canada in conjunction with university and industry partners. The BC Aquaculture and Environment Fund (the "Aqua E Fund"), delivered by the Innovation and Science Council of BC through the British Columbia Aquaculture Research and Development Committee (BCARDC), provides support for research on the environmental aspects of aquaculture that have been identified to be of concern to British Columbians. Both are recent initiatives and it is too early to identify concrete results.

New technologies have cut salmon farming costs.

To remain competitive, aquaculture companies need to continue to adopt new technology and participate in research and development. The BC industry has made great strides over the past 15 years. For example, automatic feed systems and new improved cage systems for salmon farms have cut costs.

R&D is important in the culturing of both existing and new species. The challenge in farming fish is to replicate the life cycle in captivity (called "closing the rearing cycle"), and at a cost that allows the fish to be sold at a profit. The two main life cycle

components are the hatchery phase – broodstock holding and spawning, egg incubation and larval development, and rearing to a juvenile size – and the growout or farming phase, from juveniles to market-ready adults. Typically, the hatchery phase provides the more daunting technical challenge in the growth cycle for new species.

Farmed Salmon

New vaccines and flesh quality research are priority R&D areas.

Vaccine development (e.g., IHN vaccine) and flesh quality research (e.g., Kudoa infection) have been identified by the BCSFA as priority areas for research and development. In addition, a number of innovations and technologies are already in use, or have the potential to change how the aquaculture industry operates. For example, most farmed salmon are currently hauled live to the processing plant, but improvements in dead-haul systems that allow greater salmon densities during transport and reduce the potential of disease transfer would reduce costs, assuming that quality is unchanged.

R&D facilities are lacking in BC.

However, BC lacks facilities for conducting R&D. Existing research facilities are not well equipped. However, the new Centre for Shellfish Research and the new Centre for Aquaculture and the Environment should increase capacity. Also the University of British Columbia, supported by provincial funding, is hiring a Chair in Sustainable Aquaculture.

Based on new research results, the farmed salmon industry is reassessing its CO_2 stunning techniques for slaughter. It appears advisable to dispatch the fish with the minimum of stress, and then to cool them down immediately. As a result, some companies are considering a return to percussion stunning techniques.

The BC industry is experimenting with on-land tanks to assess their production values.

As well, the industry is experimenting with different growout systems. Many environmental groups demand that farmed salmon be contained in tanks on land in closed containment systems. With sea pens, the movement of tides and currents continually brings oxygenated seawater to the pen and the oxygen facilitates the natural remediation of localized waste beneath the net pens. On-land tanks offer the benefit of avoiding interaction between farmed and wild salmon, but require constant pumping of seawater to supply oxygen and remove waste. They are, therefore, expensive to operate. Agrimarine Industries Ltd. currently has an on-land, concrete tank salmon farming operation in Cedar, near Nanaimo.

Aquaculture facilities can also be set in deep water away from shore, referred to as "open ocean aquaculture". Open ocean operations reduce conflicts with other user groups and allow better waste dispersion. However, depending on the site, they must be able to withstand more severe weather and ocean conditions. Environmental and navigational issues also differ. Open ocean aquaculture is well developed in several areas of the world, including Italy and Spain, where conflicts with the tourism industry and/or scarcity of appropriate sites require producers to move far from the coast. The New Brunswick salmon aquaculture industry is active in evaluating the potential for offshore sites.

Farmed Shellfish

Shellfish farming needs faster technology transfer.

According to our interviews, a significant constraint on shellfish farming viability and growth relates to innovation and the application of new technologies. Many growers are using old technology.

Some growers are using new technology such as optical grading systems or a Floating Upweller System (FLUPSY), a floating device that cultures small shellfish seed through their delicate nursery stage. While some growers do innovate and use new technology,

they still view their information as proprietary, so that new technology spreads very slowly through the industry. The result is substantial variation in productivity per hectare. To overcome this constraint, the industry requires a way to facilitate technology transfer.

New Species

With technical improvements, there is significant potential for new finfish species.

The markets for white-fleshed finfish products from cold waters appear strong. The BC finfish aquaculture industry is currently investigating technical and regulatory constraints on the development of viable halibut and sablefish farming. Halibut is a desirable fish to consumers for which they are willing to pay a high price but significant technical hurdles remain. With growing demand in the North American restaurant market, one BC company has started to produce sablefish. Another local producer has launched a farmed sturgeon operation.

Farming of new shellfish species must resolve some production-related issues.

In shellfish farming, the major hurdle for new species will be production-related, given strong markets for most species (e.g., scallops, sea urchins, geoduck, sea cucumbers). Mussel production can be expected to increase in BC, as many producers are adding Mediterranean (*Mytilus. galloprovincialis)* and Blue (*Mytilus edulis*) mussels to diversify their product line. The Blue mussel is more of a commodity, while the Mediterranean mussel receives a price premium for its high meat quality and attractive appearance. The industry will face strong competition from frozen, whole Blue mussels from Chile, and Atlantic Canada and New Zealand mussels.

Scallop farming is one of the world's largest aquaculture activities, in terms of both volume and value of production. Scallops command high prices in domestic and international markets. DFO, with BC government financial support, introduced the Japanese scallop (*Patinopecten yessoensis*) in the mid-1980s because of its fast growth rates and established culture methods. However, there remain several production issues that must be resolved.

A number of other species are being considered, or are under early development, for culture in BC.

- ***Geoducks*** are the highest value clam, with strong export market potential, mainly to Hong Kong and China. One company, Fan Seafoods, is culturing geoduck in BC.
- ***Abalone*** production has grown rapidly at the global level, with China being the lead producer. Prices are very high, ranging from $50 to $80 per kg, depending on product form. There are BC pilot abalone operations on Malcolm Island and near Bamfield.
- ***Sea cucumber*** fisheries are found throughout Asia, the South Pacific, New Zealand, Africa, South America, and North America (including BC). Sea cucumbers are a delicacy in China and Japan. In the mid to late 1990s, additional markets emerged for biomedical research. Culture technology in Canada remains in its infancy.
- ***Sea urchins*** have only been harvested wild to date, but BC's resource has already been depleted in some areas. Sea urchin roe is a premium product sold primarily to Japan and other Asian countries. Japanese prices are high.
- ***Kelp and seaweed*** are cultivated primarily for human consumption, but seaweed is also used in feeds, fertilizers, soil additives, and medicines. Prices for seaweed vary depending on the end use, with premium products capable of commanding high prices. One BC producer operates in Bamfield.

- ***Cockles*** are an indigenous species important to First Nations. They are common in European markets and may have some appeal to the Asian marketplace.

The development of waste products provides multiple benefits.

Another option for the aquaculture industry is to explore ways of optimizing value from waste products. By taking advantage of wastes, producers would gain another revenue source while reducing the cost of waste disposal. For example, waste could be transformed into fertilizer via composting. (Sea soil, produced from fish and forestry waste in Port McNeill, is used as a garden soil enhancer.) Scottish and Chilean companies are making bikinis out of salmon skins.

Other potential products from processing wastes include:

- ***Fish silage***. Silage is highly nutritious and is traditionally fed as a protein supplement to swine, mink and poultry. It is also included as a low-cost ingredient in aquaculture diets.
- ***Fishmeal.*** Fishmeal has historically come from the reduction of high-volume, low-value species such as sardines, anchovies and menhaden. However, as the availability of these species, other sources of fishmeal are being sought.
- ***Nutraceuticals and pharmaceuticals***. These are potential products and contain Omega-3 fatty acids.

New Seafood Preservation Technology

Various technologies around the world are extending shelf life.

Several new technologies for extending quality and shelf life of seafood products are available and in use around the world. Great strides have been made in modified atmosphere packaging (MAP) for seafood. Many of the participants at the 2003 European Seafood Show in Brussels used and promoted MAP products (e.g., traypack live oysters). MAP can increase shelf life by two or more times.

US shellfish companies employ ozonated water to "bubble" oyster meat, a process that reduces slime and bacteria and increases shelf life. Australia is using the sedative "aqui-s" for live fish shipments (wild and farmed) to Asia. This product reduces fish stress, damage and mortalities. Australia appears to be a world leader in aquaculture of high value species, such as prawns, in part due to its emphasis on innovation and research and development (Australia Prime Minister's Science, Engineering and Innovation Council 2002).

High Hydrostatic Pressure technology ("Fresher Under Pressure") refers to a process of immersing foods in water and subjecting them to extremely high pressure of more than 40,000 lbs per square inch. The pressure results in a pre-shucked product and increased food safety, due to the crushing and destruction of natural pathogens. Natural appearance and flavour are maintained.

In our interviews, industry noted that MAP, ozonated water, and aqui-s have not been approved by CFIA for use in Canada (but CFIA notes that industry has not applied to use, for example, ozonated water). This confers an advantage to BC's competitors.

More Development, Not Research

Many people interviewed cited the need to emphasize more the "development" aspect of "R&D". In their view too much R&D has been directed to basic research with not enough effort targeted at concrete applications of new products, new packaging, new equipment, etc.

6.4.5 Overall Investment Climate

The overall investment climate for BC salmon and shellfish farming is weak, with inadequate returns on investment. The commodity status of most aquaculture products, the burgeoning world supply of farmed salmon, and resulting weak prices pose substantial challenges to investment. Moreover, BC's position as a relatively high-cost producer has been exacerbated by the recent rise of the Canadian dollar against the US dollar.

Investment is going to other jurisdictions, such as Chile.

The uncertain regulatory climate, long delays and substantial costs of site approvals, and the lack of harmonization of federal and provincial regulatory requirements all contribute to the perception that investment in BC is a high-risk, low-reward opportunity. As a result, multinational salmon farming companies are investing scarce capital in other jurisdictions, such as Chile.

6.5 Supply Chain Issues and Services

6.5.1 Biophysical Capability

BC's biophysical capability could support aquaculture production at least five times current levels.

BC has a very good biophysical capability to grow both finfish and shellfish. Furthermore, at only 3,900 hectares, existing coastline used for aquaculture is miniscule, leaving much room for industry expansion. As discussed below, BC has the biophysical capability to expand aquaculture production fivefold or more.

A high percentage of coastline on the West Coast of Vancouver Island, north Vancouver Island/Broughton Archipelago, Central Coast and North Coast meet good aquaculture siting criteria, for both shellfish and finfish (Coopers & Lybrand 1997).

The provincial government has assessed the biophysical capability of BC waters to support oyster and scallop culture based on 14 environmental variables, including summer and winter water temperatures and salinity. The results indicate ample areas of coastal water capable of supporting industry expansion. They are consistent with the earlier conclusions of a Coopers & Lybrand study (Coopers & Lybrand 1997).

6.5.2 Broodstock, Smolts, and Larvae

Farmed Salmon Smolts

The BC farmed salmon industry supplies all its smolt needs from within the province. Many farming companies have their own hatcheries that produce smolts for growout. A few stand alone hatcheries exist.

Chile's lake rearing of farmed salmon gives it a competitive advantage over BC.

Smolts are much cheaper to produce in a lake-rearing environment than in land-based tank systems. However, much of BC smolt production is land-based due to regulatory difficulties in accessing lakes for rearing. In contrast, Chile has a predominantly lake-rearing system, which gives it a competitive cost advantage over BC production.

Shellfish Seed

Over 90% of clam and oyster seed or larvae are purchased from Washington State. While there are currently no difficulties in accessing this critical input, BC producers are potentially vulnerable because of dependence on foreign supply sources.

Broodstock and Hatcheries for New Species Development

Aquaculture has reasonable access to wild stocks for broodstock.

Access to BC wild stocks for aquaculture broodstock is an emerging issue and policy area. Understandably, the commercial industry does not wish to see part of the total allowable catch allocated to aquaculture operations, especially at zero cost, given that the wild fishery pays substantial co-management fees for dockside monitoring, observers and basic science. At the present time, DFO provides aquaculture with reasonable access, by scientific licence, to assist industry development. For example, the 2003 commercial halibut Integrated Fisheries Management Plan identifies one tonne as the limit for access by the aquaculture industry. A new sablefish hatchery is under development on Saltspring Island.

6.5.3 Feed

Shellfish such as clams and oysters filter feed from the marine environment and do not require feeding. Feed is the major cost of production for farmed salmon comprising a third or more of product sales. Farmed salmon are fed using nutrient-dense, dry feed pellets typically composed of 45% fishmeal and 25% fish oil. Pelagic forage fish such as anchovies caught off the coast of Peru and Chile and in the North Atlantic, North Sea, and the Baltic are a key component of this feed. Farmed salmon feed is supplied by BC companies such as EWOS, Moore-Clark, and Taplow Feeds.

Higher prices for fishmeal cause fish and other protein producers to substitute alternative feed sources.

Increasing demands on forage fishmeal as a feed ingredient would likely drive up the price of feed, which in turn would spur conversion to more vegetable-based feeds. This trend is already occurring. Two-thirds of the world's fishmeal and half of its fish are used to feed poultry, pigs, and other animals.

World Use of Fishmeal and Fish Oil 1999

	Fishmeal	Fish Oil
Aquaculture		
Marine - Salmon	7%	19%
- Shrimp	7%	3%
- Other Marine	7%	9%
Freshwater Carp, Trout, etc.	14%	15%
Poultry, Pigs, and Other Terrestrial	65%	54%
	100%	100%

Source: Wada et al 2002

Fewer fish products are going into aquaculture production.

Feed manufacturers are currently developing products that use higher proportions of vegetable protein and vegetable oil. Today's feed-to-flesh conversion ratio is about 1.1:1 for Atlantic salmon, compared to 3:1 or higher 15 years ago (and a current 2:1 in the case of chicken). Improved feeds may contribute to lower feed costs and higher conversion efficiencies. The industry already has made significant progress in decreasing its use of fishmeal and fish oil.

6.5.4 Other Goods and Services

There do not appear to be any major supply constraints for important goods and services to the BC aquaculture sector. In fact, some farmed salmon supply companies in Campbell River and Nanaimo are selling their goods and services to Chile because of stagnant industry growth at home.

However, there is a shortage of BC technical expertise for culturing new species, which could restrict industry development. It may be advisable to transfer technology through joint ventures with companies operating in other parts of the world.

6.6 Sustainability Issues

6.6.1 Feed Issues

Waste

Like other forms of animal protein food production, salmon farms produce waste in the form of uneaten feed and feces. Wastes primarily accumulate in the immediate vicinity of the cage itself, extending 15 to 30 metres beyond the perimeter of the sea pen.

Care must be taken to control wastes from salmon farms.

Excessive waste accumulation can result in conditions harmful for some aquatic species, including the farmed salmon in the cages above. For this reason, salmon farms are located in areas with good tidal flushing. Accumulations are reduced by improving feed digestibility and by accurately monitoring feed to minimize uneaten quantities.

Forage Fish

About one-third of the global forage catch is used for animal feed, with about 30% for aquaculture. World fishmeal suppliers are static; salmon feed manufacturers compete for this finite supply. As noted previously, the majority of fishmeal is used in poultry and other protein production and most fish made into feed is either unsuitable or unappealing as a direct food product for humans. As a result, salmon farming has no appreciable impact on the supply of wild fish available for human consumption.

Pollutants

Feed for agrifood protein, including farmed finfish, beef, pork, and poultry, may contain persistent organic pollutants (POPs) that endanger human health. POPs include polychlorinated biphenyls (PCBs), dioxins, and other substances produced in industrial processes. The release of POPs into the environment has been curtailed by more stringent emissions control, but POPs break down very slowly and are still detectable in trace amounts in most of the global ecosystem. Levels of POPs, stored in fatty tissue, accumulate the higher the animal is in the food chain.

CFIA is confident that POP levels in farmed salmon do not endanger human health. CFIA studies indicate that POP levels in fish feed should not cause POP levels in farmed salmon to exceed the Canadian Guidelines for Chemical Contaminants and Toxins in Fish and Fish Products or exceed USFDA tolerance levels for human consumption.

The salmon farming industry is taking action to reduce PCBs and other pollutants in feed.

Feed manufacturers can reduce POP levels by sourcing fishmeal from low-level areas and by developing methods to reduce pollutants from fish oil used for salmon feed. Using more vegetable products in feed will also reduce the POP content of farmed salmon.

6.6.2 Fish Health

Carotenoids

Carotenoids are added to farmed salmon to promote growth and health.

Wild salmon's characteristic pink to red-orange colour is due to a type of carotenoid (astaxanthin) – the natural pigment found in many red, orange, and yellow foods. Farmed salmon do not have access to the large amounts of small shrimp and fish that consume micro-algae rich in astaxanthin. Carotenoids are added to farmed salmon feed as they have strong anti-oxidant properties and aid in growth, reproduction, and tissue health. They also impart an orange-red flesh colour depending on the formulation. Without carotenoids added to their feed, farmed salmon would have very low survivability, abnormal growth and development, and pale flesh colour.

The most commonly used nutrient for farmed salmon is canthaxanthin, a synthetic carotenoid. Canthaxanthin is also used in poultry feed to give the skin and egg yolks a brighter yellow colour. The Canadian Feeds Act and Regulations limit its levels in feed to 30 grams per tonne (or mg/kg) of feed. Consumers have low risk of adverse effects from consuming approved levels of canthaxanthin.

The industry is addressing health concerns about canthaxanthin.

Some individuals and organizations have criticized the use of canthaxanthin as being unnecessary and possibly harmful to human health. In response, salmon farmers are shifting to greater use of (synthetic) astaxanthin. The BC industry lists carotenoid use on its product shipments. It has also been vigilant in educating the public that carotenoids are essential nutrients and not just colourants per se.

Infectious Hematopoietic Necrosis (IHN)

IHN is a serious health concern for farmed Atlantic salmon in BC.

Infectious Hematopoietic Necrosis is a naturally-occurring viral disease capable of causing high rates of mortality in farmed Atlantic salmon. Native to the Pacific Northwest, it was first observed in Washington state hatcheries in the 1950s. Pacific salmon appear to have evolved a degree of resistance to IHN, but resistance varies with species, viral strain, and age of fish. Since Atlantic salmon evolved in waters free of IHN, they are susceptible to infection. The disease process is very aggressive and acute. The virus ultimately kills the fish by destroying the kidney and spleen tissue. Outbreaks have occurred in Atlantic salmon farms several times in the past twelve years.

More research is needed about IHN and its impacts on farmed and wild fish.

IHN is the primary fish health concern of the farmed salmon industry. No effective vaccines are commercially available, but at least one company has a vaccine that shows promising test results. The industry is hindered by a lack of knowledge about IHN in farmed and wild fish populations, and more research is required. BC salmon farms are tested regularly for IHN as part of a new MAFF fish surveillance program. Affected farms must immediately begin isolation measures. Chinook salmon have a high resistance to IHN and some companies are increasing production of that species.

Sea Lice

Sea lice (*Lepeophtheirus salmonis)* are a naturally occurring parasite in BC coastal waters that can affect both wild and farmed salmon.

Sea lice can result in substantial aquaculture losses.

Sea lice infestations can cause substantial economic losses for salmon farmers due to mortalities, reduced growth rates, treatment costs and lower marketability. Farms ensure smolts are free of sea lice before they enter the sea pens, but lice can pass through the netting from migrating wild salmon. Strategic measures to reduce the likelihood of infestation include selecting sites with good flushing and water current, periodically fallowing production sites, and ensuring only a single-year class of salmon at each farm site.

Strict Environmental Monitoring of Salmon Farms

Under its partnership agreement with Marine Harvest Canada, the Kitasoo/Xai'xais First Nation on BC's central coast specified strict requirements for environment monitoring of its salmon farms. Kitasoo Aqua Farms Ltd. has since commissioned ongoing monitoring of the two farm sites in Jackson Pass. The Kitasoo Fisheries Program provides a trained fisheries diving crew and a professional biologist to perform the environmental monitoring. Monitoring standards surpasses those set by government agencies and monitoring is conducted independently of Marine Harvest Canada.

The monitoring includes regular sampling of local seafood (clam, prawns, sea cucumbers), which is sent to CFIA and Health Canada for contaminant determination. To date, no significant impacts have been reported. While Marine Harvest Canada has policies in place to control sea lice in the farm fish stocks, Kitasoo Aqua Farms is collaborating with UBC to develop survey and study techniques for an analysis of the sea lice/farmed salmon/ wild salmon relationships in the area. Kitasoo Aqua Farms is committed to closing down the farms if negative impacts on traditional food harvesting are demonstrated.

Compared to other jurisdictions such as New Brunswick, sea lice have not yet posed a significant problem for farmed salmon in BC. Infestations can be treated by using anti-parasitic compounds, which are strictly regulated and controlled, in feed. While the parasite does not threaten the viability of BC salmon farming, critics claim, despite little scientific evidence, that the dramatic decrease in the 2002 Broughton Archipelago pink salmon returns was due to sea lice infestation caused by wild smolts passing salmon farms during their out-migration.

BC initiatives have been launched to address sea lice infestation.

A number of initiatives are underway, with industry's full support, to monitor, research, and control sea lice. In February 2003, MAFF launched an action plan to minimize risks to wild salmon in the Broughton Archipelago. Baseline sea lice information will be collected from all farms to develop appropriate management decisions. A three-day Science Forum on Sea Lice held at the UBC Centre for Aquaculture and the Environment in 2003 examined technical information and set research priorities. In addition, DFO announced the three-year, $700,000 Pink Salmon Action Plan that will involve monitoring, research and public consultation. The BC Aquaculture Research and Development Committee (BCARDC), using Aqui-E funds, has supported additional research programs on sea lice.

Therapeutant Use in Salmon Aquaculture

With improved management and vaccination programs, the use of therapeutants or drugs in salmon aquaculture has declined dramatically. In comparison to the beef, pork and poultry industries, the annual antimicrobial usage in salmon aquaculture is small.

Antibiotics and other drugs are much less in aquaculture than in terrestrial farming.

While terrestrial agriculture continues to routinely add subtherapeutic doses of antibiotics to feed and drinking water in order to promote growth, salmon aquaculture uses antibiotics only to treat disease. Moreover, salmon farmers have access to only a few drugs by veterinary prescription, while a wide range of drugs and pesticides are readily available to the general public for use in poultry and terrestrial animal-rearing.

Drug residues in farmed salmon and the marine environment are not a threat to human health.

The primary route of drug delivery to farmed salmon in net cages is via medicated feed. Depending on the drug administered, traces may persist in the salmon for a period of time. However, salmon are not harvested until drug residues fall below stringent regulatory standards, and regulatory agencies conduct routine inspections at processing plants to ensure the requirements are being met. Consequently, drug residues in farmed salmon do not pose a human health concern.

Drugs used in salmon aquaculture enter the water column and sediment through waste feed and feces. While residues have been found in wild marine organisms, they are not a threat to the health of either the organisms or humans who may consume them.

Fish Health Management Plans

MAFF requires fish aquaculture facilities to develop up-to-date Fish Health Management Plans (FHMPs), which are enforced for private companies as a condition of an aquaculture licence. A June 2003 document, *Required Elements of Fish Health Management Plan,* describes fish health information that operators must include in their plans. These requirements include maintaining information on fish, monitoring disease, identifying and managing risks such water quality and vaccination, minimizing exposure to disease, and ensuring appropriate use of drugs and chemicals.

6.6.3 Safety and Traceability

Farmed Salmon Safety

Processors must have a HACCP-based quality control program.

The Canadian Food Inspection Agency (CFIA) oversees the Quality Management Program (QMP), which requires all federally registered fish processing plants to develop and implement an in-plant quality control program. All plants that process farmed fish and shellfish must be federally registered. QMP is based on Hazard Analysis Critical Control Point (HACCP) principles (see section 3.3.2).

Each lot of farmed fish that enters a federally registered processing plant is accompanied by a drug declaration form. In accordance with CFIA's recall procedures, the plant assigns each lot a trip or lot number that is linked to information on the source company, site, pen, harvest transport vessel or truck, and number of fish in the lot. After processing, the fish are packaged in transport containers labelled with bar codes including the trip or lot number. Buyers are responsible for keeping records that match the incoming lot number to outgoing products. This process is continued down the distribution chain. For product exported to the US, the recall regulations are similar.

While HACCP use at the processing level is a major step towards a science-based inspection system, food safety and quality assurance starts with the producer. A successful On-Farm Food Safety (OFFS) program requires each farmer to identify, evaluate, control and/or prevent farm food safety hazards. The industry has made

considerable effort to ensure product safety (e.g., through the codes of practice developed by the BCSFA and the BC Shellfish Growers Association).

Development of an on-farm food safety program is important to securing export markets.

CAIA is currently trying to develop a national HACCP-based OFFS for aquaculture products in Canada. Successful implementation of such a program will be increasingly important, as export markets (e.g., the EU) begin to stipulate that farms have HACCP plans in place.

Feed Supplier Quality Assurance (SQA) programs are at various stages of development in the province. An integrated salmon grower and feed manufacturer allows for traceability of feed source from origin to processed product.

Shellfish Safety

The Canadian Shellfish Sanitation Program works to protect consumer health.

The development of the shellfish farming industry depends heavily on effective sanitary and biotoxin monitoring programs to ensure product safety and protect human health. The Canadian Shellfish Sanitation Program (CSSP) is a joint program of DFO, CFIA, and Environment Canada designed to reduce the risk of consumer illness due to contaminated or poor quality shellfish. Environment Canada is the lead agency with regard to monitoring water quality and conducting sanitary and bacteriological surveys. CFIA is responsible for regulating shellfish processing operations including marketing and trade. The main role of DFO is to enforce compliance with CSSP regulations.

CSSP meets the standards and criteria established by the USFDA's National Shellfish Sanitation Program, so that Canada is approved to export live shellfish to the US. The only other countries that are able to do so are New Zealand, Korea, Mexico, and Chile.

CFIA runs a biotoxin surveillance program.

CFIA is also responsible for managing the program to monitor marine biotoxins, a group of naturally produced toxic chemicals that can sometimes accumulate in shellfish. Most biotoxins are produced by microscopic marine algae, such as phytoplankton, which are ingested by filter-feeding shellfish. To reduce the risk of illness from consuming affected shellfish, CFIA coordinates a biotoxin surveillance program. Mussels are deployed at sampling stations in harvesting areas and collected periodically to test for the presence of biotoxins.

Mussels, which accumulate biotoxins more quickly than other shellfish species, are used to detect contamination before biotoxins accumulate in oysters and clams. If shellfish exceed the limits of toxin sampling, DFO closes the area. The closure continues until biotoxin levels in mussels fall below specified limits and the shellfish have had enough time to be flushed naturally. Throughout the closure, the contaminated area is patrolled and closure signs are posted as a warning.

Monitoring water quality for fecal contamination (sanitary survey) is a critical issue as urbanization continues to impact water quality. By 2000, there were approximately 105,000 hectares closed to shellfish harvesting in BC, an increase of two-thirds over the area closed in 1976. Scientific improvements in detecting bacterial pollution sources hold the promise of refining the number, size and duration of closures, and identifying ways to deal with affected marine waters.

Phytoplankton monitoring is being used and required for imported shellfish in other countries.

Although phytoplankton monitoring can provide early warning and mitigate some of the negative impacts of harmful algae blooms, it is not presently in use in BC. Quebec, PEI, Maine, California, New Zealand, and the EU use this monitoring, and it is becoming a growing requirement for shellfish imports into many countries. Other advanced detection techniques are being tested, including a combination of satellite imagery, remote sensing, and stakeholder involvement to track harmful blooms.

Water quality and biotoxin monitoring exclude BC's North Coast.

Current water quality and biotoxin monitoring programs do not cover the entire BC coast, thereby limiting shellfish expansion to areas of testing coverage (see Case Study 7). Industry and government agree that methods and delivery of water quality monitoring can be significantly improved, so as to minimize the frequency and duration of harvest closures while ensuring public safety.

Attempts are being made to directly test product with rapid detection kits but development is slow, and acceptance by regulatory authorities is problematic.

Traceability

Tracking product safety for aquaculture is improving.

Product traceability and related record keeping are essential elements of quality management systems such as CFIA's QMP. Currently, traceability in BC is assured from the hatchery phase for farmed salmon but only from the processing stage for farmed shellfish. CAIA has recently initiated development of a HACCP-based on farm food safety program for all aquaculture in Canada.

Larger companies use software for tracking fish populations.

Larger, vertically integrated companies rely on in-house or third party software, such as Superior® or Farm Control®, to track fish populations through the production cycle. These systems are capable of tracking fish groups from tank-to-tank movements in the hatchery through the marine phase, where fish are likely to be moved pen-to-pen or site-to-site at least once during the lifecycle. The systems also track fish populations with veterinary prescribed withdrawal times, so that the withdrawal period is flagged. Smaller producers use less integrated systems or handwritten records.

Full traceability is becoming a market requirement.

Given the concern of most consumers about the quality and safety of their food, full traceability of aquaculture products could be a marketing tool. However, traceability is becoming a necessity as important markets for BC aquaculture products are increasingly demanding assurances of product safety and quality such as full traceability programs.

6.6.4 Production

Kudoa

Kudoa infections are another major health concern for BC farmed salmon.

Kudoa (*Kudoa thyrsites*) is a parasite that infects a variety of species including Pacific salmon, Atlantic salmon, Pacific hake, and Pacific halibut. The infection attacks the muscle tissue of the fish host and results in soft tissue which reduces their market acceptance. Prevention and control of the parasite is difficult because methods of transmission are not yet conclusive. Kudoa does not pose any risk to human health.

Detecting Kudoa prior to harvest is difficult as live fish do not manifest visible symptoms. Therefore, most infections are not detected until processing. To improve detection during processing, researchers are now developing a test to indicate intensity of infection. Kudoa remains one of the primary production concerns in BC for the farmed salmon industry. In April 2002, the Minister of Fisheries and Oceans approved a $215,400 project to study risk factors associated with Kudoa.

Production Monitoring

Under the Aquaculture Regulation Schedule of the provincial *Fisheries Act*, each aquaculture operation or site must be licensed. A condition of the licence is the annual reporting of harvest quantity and value by species on the Annual Aquaculture Statistical Report (ASAR). Another condition is a maximum production level for the site.

Case Study 7: North Coast Water Quality and Biotoxin Program Society

Issue

Water quality testing, under the Canadian Shellfish Sanitation Program, is a basic food safety requirement for the commercial harvesting and sale of shellfish. However, in 1964 the federal government curtailed biotoxin monitoring on BC's North Coast, creating a huge barrier to aquaculture development. The lack of monitoring has also jeopardized the health and safety of many First Nations residents who, while guaranteed access to shellfish for food, social and ceremonial purposes, are officially prohibited by DFO from harvesting due to the lack of biotoxin monitoring. More generally, a 40-year closure of one-third of BC's coastline for most shellfish activity has affected recreational harvesting, First Nation traditional harvesting, and the potential for shellfish farming alike.

Response

The North Coast Water Quality and Biotoxin Program, based in Prince Rupert, began as a community-driven pilot project in 1998. Its goals were to re-establish an official biotoxin sampling and testing program for the region, and to facilitate commercial shellfish aquaculture development. Participants in the non-profit NGO include local First Nations and non-First Nations communities, shellfish farmers, scientists, economic development groups, and local, provincial and federal governments.

Biotoxin sampling occurs weekly from May 1 through October 31, and every two weeks form November 1 through April 30. At present, there are 22 Biotoxin Monitoring Stations and four affiliated stations in Nisga'a Territory, with proposals for three additional stations. Three biotoxins are monitored: Paralytic Shellfish Poisoning (Red Tide), Amnesiac Shellfish Poisoning (Domoic acid), and Diarrhetic Shellfish Poisoning.

Results

In June 2001, Environment Canada conducted shoreline surveys and faecal coliform testing in Hartley Bay, Kitkatla, Humpback Bay, Metlakatla, and Lax Kw'alaams. The Department's water and biotoxin testing requirements, and those of CFIA, have been met. The program is currently working with DFO to enable areas of the North Coast to be officially opened, based on monitoring results, for First Nations traditional shellfish harvesting.

Lessons Learned

The North Coast Water Quality and Biotoxin Program is a unique, cooperative venture between industry, government, First Nations and local community members. With limited funding, this grassroots organization has met a series of challenges to find a viable mechanism for water quality testing on the North Coast. The use of volunteer labour and creative funding sources, such as the Canadian Rural Partnership, helped establish the program. The development of local laboratory capacity (Northern Laboratories Ltd. and Ocean Ecology) was also essential given the remoteness of communities and the time constraints involved in testing. In addition, the program has garnered community support for the importance of water quality testing, as well as the significant economic opportunities that shellfish aquaculture can provide.

However, the Program has been operating with "soft" money provided by a variety of groups. The Program is in jeopardy as of April 1, 2004. Three years of funding have been secured from DFO for administration – an equal amount is needed for sample collection and transport until there is sufficient harvesting and aquaculture activities to support the program. A valuable northern program may be lost without additional funding.

6.7 Industry Liaison and Relationships

6.7.1 Industry Associations

The two primary aquaculture industry associations in the province are the BC Salmon Farmers Association and the BC Shellfish Growers Association.

BC Salmon Farmers Association (BCSFA)

This 30-year-old association serves as a forum for communication, a lobbying vehicle, a point of contact for stakeholders and the public, and a focal point for industry-wide initiatives (e.g., development of the 2001 Code of Practice). All salmon farming operators in BC are members. The Ahousaht First Nation recently joined as the first aboriginal member. BCSFA membership includes service and supply companies as well as farmed salmon producers.

BC Shellfish Growers Association (BCSGA)

Originally formed as the BC Oyster Growers Association, BCSGA has been the voice of the shellfish industry since 1948. Over the years the association has changed and evolved to reflect diversification of the industry. The BCSGA is non-profit and represents the majority of shellfish growers in the province in addition to industry suppliers and service providers. The priorities of the association are to build effective support structures and relationships among stakeholders, to advocate for a secure business climate that will promote better investment and profits, to support scientific research and technological development, and to increase the growth and diversity of opportunity for the industry.

Aboriginal Aquaculture Association of British Columbia (AAABC)

Recently formed, AAABC considers aquaculture a promising economic development opportunity for First Nations. The association brings together First Nations, industry and government representatives to exchange information, network, and provide support. It aims to inform and educate First Nations, coordinate monitoring programs for salmon farms, and foster strategic alliances with the aquaculture industry.

Society for the Positive Awareness of Aquaculture (SPAA)

SPAA is a BC non-profit organization composed of industry and community interests whose mission is to disseminate accurate information on the aquaculture industry and its products. The Society held an Aquaculture Awareness Day festival in Campbell River in May 2003.

6.7.2 Integration and Strategic Alliances

Cooperation and alliances are common in salmon farming.

BC industry associations also belong to national associations, most notably the Canadian Aquaculture Industry Alliance (CAIA). CAIA represents the interests of Canadian aquaculture operations, feed companies and suppliers, as well as provincial finfish and shellfish aquaculture associations. Its activities include image building, education, advocacy, coalition building, national integration, and membership services. CAIA, in conjunction with Human Resources Development Canada and others, has launched an initiative to identify and meet the industry's human resource needs.

Most BC salmon farming operations are part of international food production companies with processing, marketing and distribution arms in North America and around the world (e.g., Norway, Chile, Continental Europe). Some have European parents that are diversified into other farmed finfish, such as cod, halibut, or sea bream, as well as chicken and other protein sources. This vertical integration and the broad scope of parent operations give the BC industry knowledge about protein value chain issues throughout the world.

Salmon of the Americas

To maintain and grow US markets for farmed salmon, industry realized the need to respond to market challenges, especially increasing pressure from environmental groups. Salmon producer associations in the US, Canada and Chile recently signed an agreement called Salmon of the Americas (SOTA) to promote farmed salmon as a top quality, nutritious product and demonstrate that salmon farming is environmentally sustainable. BCSFA is a signatory. This is the first time in the history of salmon farming that fierce international competitors have been able to put aside their differences and see the benefit of collaboration to achieve common objectives.

The shellfish industry remains fragmented.

In contrast, the perspectives and strategic alliances of the BC farmed shellfish sector are narrower and much less expansive. In particular, relationships between growers and processors are fragmented and no strong marketing organization or agent exists for the many small producers. The success of the New Zealand mussel culture industry is largely attributable to its coordinated marketing (see Case Study 8).

6.7.3 Public Perception

The public has mixed views about salmon farming.

The Canadian public has mixed emotions about salmon farming, and aquaculture in general. On the one hand, farmed salmon is a staple of the restaurant menu and the retail seafood counter alike. BCSFA and its member companies have contributed to a variety of community events (e.g., the Van Isle 360 yacht race, Port Alice cancer fundraiser), and have generated considerable local good will. In addition, BCSFA has hosted researchers, financial institutions, media, grocers, and capture fishery interests on farm and processing plant tours.

On the other hand, the industry has been under attack, mainly by environmental groups, with respect to its impact on the environment (e.g., wild fish), human health issues (e.g., from carotenoid use), and the economy (e.g., wild fish markets). As discussed earlier, many of these issues are spurious or misrepresented. Others require scientific research that is already underway with the support and cooperation of aquaculturists.

This divided public perception is reflected by the results of an August 2003 Ipsos Reid poll sponsored by BCSFA. People were asked the question: "Based on what you know about salmon farming, do you support or oppose salmon farming in BC?" In response, 45% indicated that they strongly or somewhat supported the industry, 46% were strongly or somewhat opposed, and 9% were undecided.

Case Study 8: The New Zealand Mussel Industry Council

New Zealand mussel production provides an example of an industry that has worked cooperatively on many fronts to achieve sustained viability. Part of the industry's cohesive nature can be attributed to the fact that, while oysters, clams and abalone are farmed in New Zealand, most production has been focused on the Greenlip mussel (*Perna canaliculus*), which is marketed under the registered name Greenshell® mussel (see www.greenshell.com). Therefore, all industry innovations, technological improvements and marketing advancements benefit the industry as a whole.

Another reason behind New Zealand's success is the strong leadership of its Mussel Industry Council in helping the industry work together toward common goals. The Council has been instrumental in spearheading activities around product safety and quality, such that today the extensive monitoring of growing waters for faecal contamination and biotoxins is largely industry-led and funded. The Council has also been a world leader in the development of environmental management systems. In fact, its Executive Director has provided guidance to other shellfish farming countries, including Canada and the US, in preparing industry codes of practice.

Strong leadership and cooperation have resulted in significant industry expansion. From its small beginnings in the 1970s, the New Zealand mussel industry has grown to a total annual production of around 75,000 tonnes. At present, there are 605 mussel farms encompassing 2,850 hectares, yielding an export return greater than $Cdn 43,000 per hectare wholesale value. In comparison, the BC shellfish farming industry currently has 482 farms on 2,114 hectares averaging a return of approximately $14,000 per hectare wholesale value (with farmgate value about half this amount).

A recent Pacific Fisheries Resource Conservation Council (PFRCC) report acknowledged: 1) the divisiveness of public debate and lack of constructive dialogue and solutions on salmon aquaculture, and 2) the need to convene a Salmon Aquaculture Forum to advise governments and inform the public on what is required to achieve an environmentally appropriate, socially beneficial, and economically viable salmon aquaculture industry (PFRCC, December 2003).

Shellfish aquaculture has also been the subject of controversy.

Shellfish farming is not immune from public controversy. For example, a key issue in the 2002 North Island Straits coastal planning process were the conflicts with viewscapes and upland property owners arising from shellfish tenure expansion around Denman Island.

To a large extent, these controversies and mixed public opinion reflect the newness of the industry. The public image of salmon farming can profoundly affect industry performance through government policy and other influences. For example, industry reports that public perceptions inhibit their local recruitment efforts and contributes to worker turnover.

An updated, credible economic analysis is needed to help inform public opinion.

A major deficiency of BC finfish and shellfish aquaculture sectors is the lack of a current, credible analysis of economic costs and benefits, particularly to coastal communities and First Nations, from industry development and operation. The last formal economic reporting for the BC farmed salmon industry occurred for 1993 (see ARA, 1994). This kind of analysis would allow the public and stakeholder groups to assess any environmental concerns against the economic development benefits.

The New Brunswick salmon farming industry, a much smaller industry than its BC counterpart, has sponsored just such an analysis twice over the past five years, and modelled the analysis on the 10-year-old BC report (Doane Raymond and ARA 1998; Stewart 2001). The industry received funding from the Atlantic Canada Opportunities Agency (ACOA) to sponsor the analysis.