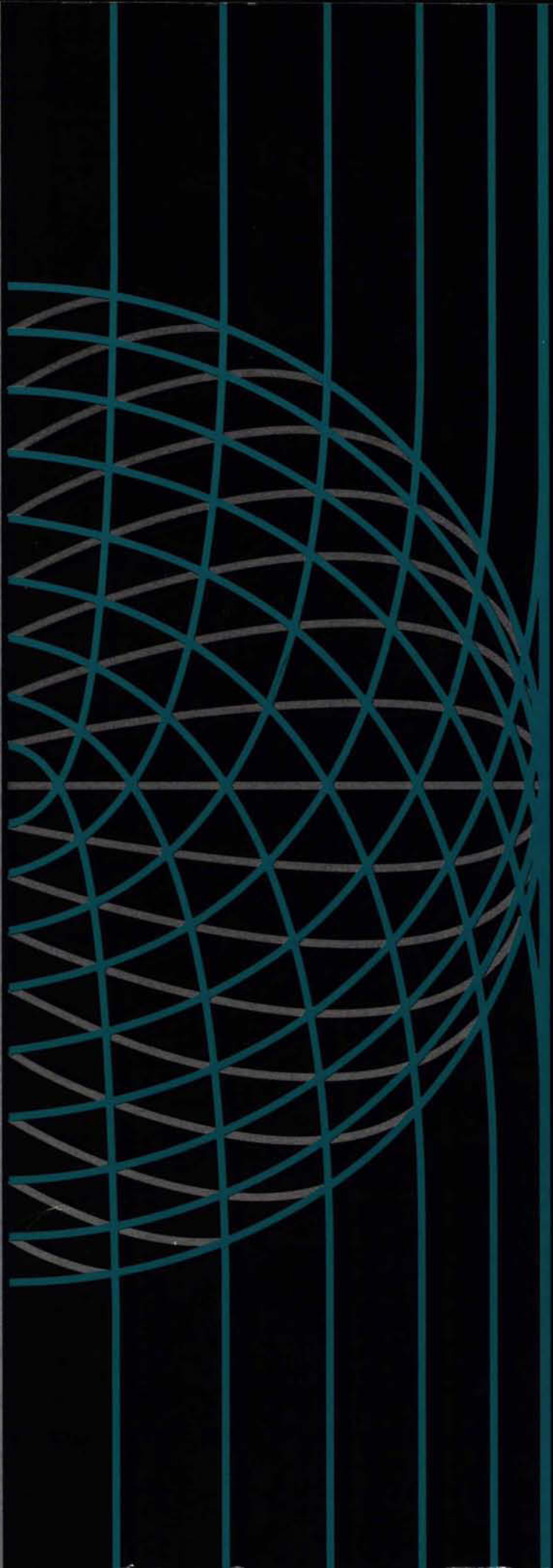
Aquaculture

INDUSTRY PROFILE



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Fax: (403) 873-6228

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Canada

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INDUSTRY PROFILE

1990–1991

AQUACULTURE

FOREWORD

In a rapidly changing global trade environment, the international competitiveness of Canadian industry is the key to growth and prosperity. Promoting improved performance by Canadian firms in the global marketplace is a central element of the mandates of Industry, Science and Technology Canada and International Trade Canada. This Industry Profile is one of a series of papers in which Industry, Science and Technology Canada assesses, in a summary form, the current competitiveness of Canada's industrial sectors, taking into account technological, human resource and other critical factors. Industry, Science and Technology Canada and International Trade Canada assess the most recent changes in access to markets, including the implications of the Canada-U.S. Free Trade Agreement. Industry participants were consulted in the preparation of the profiles.

Ensuring that Canada remains prosperous over the next decade and into the next century is a challenge that affects us all. These profiles are intended to be informative and to serve as a basis for discussion of industrial prospects, strategic directions and the need for new approaches. This 1990–1991 series represents an updating and revision of the series published in 1988–1989. The Government will continue to update the series on a regular basis.

Michael H. Wilson
Minister of Industry, Science and Technology
and Minister for International Trade

Introduction

The Canadian seafood and marine products sector comprises firms engaged in the harvesting, processing and marketing of fish, shellfish and marine plants and animals, and in the processing and marketing of by-products such as fish meal and oil. The sector may be divided geographically into east (Atlantic) coast, west (Pacific) coast and freshwater (inland) commercial fisheries. Plants process fish harvested by Canadian fish harvesters, produced by Canadian aquaculture operations or imported from foreign suppliers for further processing in Canada. Imported finished product is also marketed by the Canadian industry to complement its own product line.

Fish of all species is perceived as being a healthful food. This perception is expected to sustain the increase in per capita fish consumption that has been enjoyed since the late 1980s. In 1989, Canadians ate an estimated 7 kilograms of fish, compared with 63 kilograms of red meat and almost 28 kilograms of poultry.[1]

Canada, with the world's longest coastline and second largest continental shelf, has important sovereign interests in three bordering oceans. Some 7.5 percent of Canada's land surface is covered by fresh water, which represents 16 percent of the world's total surface area of fresh water.

Canada's 370-km (200 nautical miles) Exclusive Fishing Zone (EFZ), which is generally recognized by most nations, was declared in 1977 following the Law of the Sea conferences. The Canadian seafood and marine products sector is a major world exporter of fisheries products, and it provides hundreds of small communities with an important source of jobs and resources.

[1]Sources: *Apparent Per Capita Food Consumption in Canada, Part I*, Statistics Canada Catalogue No. 32-229, annual; and *Apparent Per Capita Food Consumption in Canada, Part II*, Statistics Canada Catalogue No. 32-230, annual.

The seafood and marine products sector had a national output in 1989 worth about $3.2 billion, less than 1 percent of the gross domestic product (GDP). However, the sector's economic importance in the regions where its activities are concentrated is much greater than this value suggests. In Newfoundland, where fishing and fish processing provide the only economic base for many communities, the sector accounts for 20 percent of the gross provincial product (GPP). In 1989, the fishery industry in both Prince Edward Island and Nova Scotia accounted for 16 percent of the GPP, 5 percent in New Brunswick, 3 percent in British Columbia and less than 1 percent in Quebec. In the Northwest Territories, the northern regions of the Prairie provinces and some communities in all the coastal provinces, the commercial fishery is one of the few, and in some cases the only, economic activity available to many people, including the aboriginal population.

This profile is one of six which describe the fisheries sector

- *Seafood and Marine Products – Overview*
- *Seafood and Marine Products – East Coast*
- *Seafood and Marine Products – West Coast*
- *Seafood and Marine Products – Freshwater*
- *Fish Meal and Fish Oil*
- *Aquaculture*

Structure and Performance

Structure

Aquaculture is the husbandry of aquatic plants or animals that are in the custody and under the control of an individual or organized group of persons until the plant or animal is harvested or released to the wild. For example, some species, such as salmon, may be the offspring of carefully selected brood stock and may spend their entire life cycle in captivity. Other species, such as mussels, may be raised under controlled conditions from naturally produced spat (eggs). Still others may be raised in hatcheries to a small juvenile stage, then released to restock lakes and streams for the benefit of the sports and commercial fisheries.

Aquaculture has been practised for centuries, particularly in East Asia. Even today, despite the rapid growth of the industry in temperate-zone countries, this region dominates; in 1988, some 72 percent of world tonnage and 64 percent of world value came from China, the two Koreas, Japan and the Philippines (Table 1). In 1988, about 30 percent of world tonnage consisted of carp and tilapia (a warm-water species) and 25 percent was made up of marine plants (various algae), while salmon and trout accounted for only 2.9 percent.

Table 1 — World Aquaculture Production, 1988

Selected countries	Volume (millions of tonnes)	Value (U.S.$ billions)
China	6.60	7.95
Japan	1.42	4.57
Republic of Korea	0.90	0.55
North Korea	0.83	0.49
Philippines	0.60	0.72
Taiwan	0.30	1.20
Norway	0.09	0.59
Canada	–	–
Other	3.71	6.38
World total	14.45	22.45
Species		
Carp and tilapia	4.26	
Marine plants	3.62	
Mussels	1.03	
Oysters	0.94	
Shrimp and prawn	0.45	
Trout and salmon	0.42	
Other	3.73	
World total	14.45	

Source: Food and Agriculture Organization.

Virtually all East Asian aquaculture production except shrimp is for internal consumption in countries where fish is the basic animal protein (shrimp is the exception because of its high export value in comparison with other fishery products). Aquaculture production in Asia does not have a significant or direct impact on world trade or on the business of aquaculture as it is known in Canada because it is conducted on such a small scale, usually on family-owned farms.

Although Canada was a pioneer in the development of hatchery technology and is a world leader in fish vaccine development and disease control, aquaculture is a relatively new industry in this country and is confined principally to four species groups: salmon, trout, oysters and mussels. They form the basis of temperate-zone aquaculture and, along with shrimp, are the most important aquaculture products in international trade.

In 1989, direct employment in the farming of salmon, trout, oysters and mussels was estimated at 1 885 workers (full-time equivalent). Projections for the year 2000 range from

Table 2 — Comparison of Canadian and World Farmed-Salmon Production (thousands of tonnes)

	1981	1985	1986	1987	1988	1989
British Columbia	0.18	0.12	0.4	1.2	6.6	12.4
New Brunswick	0.02	0.35	0.6	1.3	3.3	4.5
Canada total	0.20	0.47	1.0	2.5	9.9	16.9
Canada	0.20	0.47	1.0	2.5	9.9	16.9
Norway	8.4	28.7	45.7	47.4	80.4	117.0
Other	2.4	18.6	22.7	37.9	49.5	89.1
World total	11.0	47.8	69.4	87.8	139.8	223.0

2 600 to 4 900 people. Canadian aquaculture output of all species is about 10 percent of the volume from the wild fishery and is growing rapidly. Of the Canadian aquaculture industry subsectors, salmon farming is the largest and fastest growing.

On the East Coast, water temperatures have restricted large-scale development of salmon farming to an area around the mouth of the Bay of Fundy in New Brunswick, where Atlantic salmon (*Salmo salar*) is the species of choice. In 1989, there were 40 growers in this area, with a production of 4 500 tonnes valued at $42.1 million (Table 2). Located at the Bay of Fundy are two large corporate organizations, one large marketing co-operative and a number of independent operators. Virtually all fish product is sold fresh in the north-eastern U.S. market; the rest is sold in Central Canada. The area has a development potential for a total of 52 sites, which could boost annual production capacity to 9 575 tonnes, with a value of $100 million.

The New Brunswick industry is supported by four feed producers and 12 hatcheries. About 500 people are directly employed, and another 500 are employed in spinoff industries such as supplies, equipment and services.

Elsewhere in Atlantic Canada, water temperatures for salmon aquaculture are not favourable. Land-based farms instead of sea cage installations have not yet proven economically viable because the start-up costs are so high, but they are being developed as a possibility for future expansion.

In British Columbia, water temperatures are more favourable and salmon aquaculture has grown much more rapidly, from four sites in 1981 to 135 in 1989. Most of this growth took place between 1984 and 1988. In 1988, an oversupply of farmed salmon on world markets led to a drop in prices and a rationalization of the British Columbia industry.

Although individual farms are relatively small, ownership in British Columbia is being concentrated increasingly in the hands of a small number of large corporations. This trend is partly the result of the inability of many of the entrepreneurial pioneers to meet the high demand for working capital during the start-up years before there is revenue from sales. It is also a result of the growing recognition among established fish processors of the potential for aquaculture to complement their existing business profitably.

At the beginning of the 1990 season, the salmon industry in British Columbia consisted of 72 producers operating 135 sites and employing 1 400 people. Salmon farms were first established along the Sunshine Coast in the Sechelt area just north of Vancouver, but are now concentrated farther north around Campbell River and Port Hardy. Further development has begun along the west coast of Vancouver Island. In 1988, some 74 percent of the farmed salmon was sold fresh, 25 percent frozen and about 1 percent smoked. Of the total, 70 percent was sold in the United States, 23 percent in Canada and 7 percent in other countries, mainly Japan.

Because of the long association of the commercial fishery with the Pacific salmon species (genus *Oncorhynchus*), the first and still most common salmon farmed in British Columbia are coho and chinook. These species are more familiar than Atlantic salmon in the Pacific Rim markets. However, because of the dominance of Norwegian Atlantic salmon on the world market and because it more easily adapts to domestication, many firms are adding Atlantic salmon to their product lines.

Whether Atlantic salmon becomes the dominant farmed species on the Pacific coast depends principally on two emerging trends. Japan, which historically has been a market for the Pacific species, may change over to Atlantic salmon in response to an aggressive marketing campaign by Norway, the world's largest producer of farmed Atlantic salmon; the established British Columbia salmon processors, who already market 60 percent of the farmed product, may influence the species mix at the farm level as they further integrate the marketing of wild and farmed fish to maintain a year-round supply of product for the U.S. fresh fish market.

Salmon production in British Columbia, which was negligible until 1986, reached 6 590 tonnes valued at $39 million in 1988. The 1989 production was estimated at 12 400 tonnes valued at $72 million. As a consequence of industry rationalization, approximately 75 percent of this output is produced by six companies (out of a total of 72).

Trout aquaculture, although smaller in volume, is a much older part of the industry than salmon aquaculture and, because trout can be raised in fresh water, the industry is located in many inland centres as well as on the coast. Freshwater trout production in 1989 was estimated at 3 460 tonnes, of which 55 percent occurred in Ontario, 35 percent in Quebec and approximately 10 percent in the other regions. In addition,

Table 3 — Shellfish Aquaculture

Volume (tonnes)

	1986	1987	1988	1989
Oyster production, British Columbia	2 870	3 000	3 700	3 900
Mussel production, Prince Edward Island	1 220	1 035	1 440	2 680

Source: Fisheries and Oceans Canada.

about 300 tonnes of farmed marine trout were harvested along the Pacific coast, and 225 tonnes were harvested on the Atlantic coast.

Principal trout-farming operations are concentrated near major cities — far enough away to have access to affordable land but close enough to permit fresh product delivery to metropolitan foodservice distributors and outlets. The Canadian retail market for frozen pan-sized trout is generally served more economically by imported product from regions where the warmer climate permits longer seasons and faster growth.

Shellfish aquaculture is now well established on both the Atlantic and Pacific coasts (Table 3). Oysters are the principal shellfish product in British Columbia. Mussels and oysters are the principal products on the Atlantic coast. While Quebec, Nova Scotia, New Brunswick and Newfoundland have developing mussel culture industries, the majority of production comes from Prince Edward Island. There is also experimental and early commercial development work involving a number of other shellfish species such as scallops, clams and abalone. Commercially viable aquaculture of some of these species, particularly scallops and some types of clams, can be expected during the next decade.

Unlike vertebrate fish such as salmon, shellfish do not normally have to be fed, because they take their nutrients from the water in which they are raised. Consequently, shellfish do not require continuous attention, and many early shellfish leases were held by people who tended them on a small-scale, part-time basis. Today, however, the successful companies tend to be those with larger holdings that receive full-time attention from experienced personnel who control disease, predators and other threats to a healthy environment.

Many farmed shellfish are considered superior to their wild counterparts because they can be grown free of sand particles in the meat, have thinner shells and higher meat content, and are easier to supply on a continuous basis. Canada has a competitive advantage because the country has many sheltered and clean-water locations where shellfish sites can be established. Some of the shellfish industries in other countries are hampered by increased pollution of estuarial or coastal regions.

Oyster farming has been practised in British Columbia since the early 1900s. It reached a peak of 5 900 tonnes in 1963, but declined during the next 18 years because of poor seed stock and cultivation practices. These difficulties have since been overcome, and the industry has grown steadily since 1981. In 1989, according to British Columbia government statistics, there were 163 oyster producers operating 422 sites and employing 500 people. Estimated production for 1989 was 3 900 tonnes valued at $3 million, the principal market being the western United States. The principal competition for the North American market comes from the Gulf of Mexico and Chesapeake Bay in the United States, both of which are experiencing difficulties because of deteriorating water quality and other factors that affect productivity.

Oyster production on the east coast is concentrated in Prince Edward Island, which produced 1 461 tonnes (66 percent of the total for the region) in 1988; New Brunswick produced 611 tonnes (28 percent) and Nova Scotia 140 tonnes (6 percent). By 1989, Atlantic coast oyster production had risen to approximately 2 420 tonnes, of which 78 percent or 1 895 tonnes came from Prince Edward Island.

The greatest constraint to growth of oyster culture is the need for a larger, more reliable seed supply and for additional financing and market development. As on the west coast, the two most significant positive factors are proximity to the U.S. market and the availability of additional grow-out sites to support continued expansion. At the same time, not only are U.S. growers running out of available sites, but also the quality of their existing sites is declining. This is particularly true in Chesapeake Bay and along the Gulf of Mexico coast, where water pollution and disease are limiting output.

The second most important shellfish in the Canadian aquaculture industry are mussels. In addition to oysters, Prince Edward Island is the major Canadian producer of mussels. In 1989, Prince Edward Island produced about 2 680 tonnes of mussels, 78 percent of Canada's production, with New Brunswick and Nova Scotia contributing most of the balance. Quebec and Newfoundland grew less significant quantities of mussels in 1989, but production is increasing in both provinces. Although mussel culture has been attempted in British Columbia, it has not been very successful, mainly because of the damage caused by predatory birds such as ducks that winter over along the Pacific coast. Another problem for would-be west coast mussel farmers is summer mortality of the molluscs, possibly due to high water temperatures and variable salinity.

Table 4 — Canadian Aquaculture Production, Selected Species

	1988		1989	
	Volume (tonnes)	Value ($ thousands)	Volume (tonnes)	Value ($ thousands)
Salmon and marine trout				
British Columbia	6 775	40 000	12 700	76 500
Atlantic	3 550	45 400	4 900	46 100
Subtotal	10 325	85 400	17 600	122 600
Shellfish				
British Columbia	3 740	2 805	3 950	3 095
Atlantic	4 260	6 075	5 810	10 350
Subtotal	8 000	8 880	9 760	13 445
Rainbow trout	3 020	19 000	3 460	20 700
Total	21 345	113 280	30 820	156 745

Source: Fisheries and Oceans Canada.

The cultivation of marine plants is a significant part of the aquaculture industry. One company in Nova Scotia is growing a special strain of Irish moss (*Chondrus crispus*) for producing carrageenan, a natural emulsifying agent used in many food and pharmaceutical products. At least two British Columbia companies are growing other species of algae for food use.

Aquaculture technology is being used to grow small lobsters to market size and to regulate their moulting cycle to extend the commercial season. Aquaculture technology has been applied to growing small cod to a more commercially attractive size. Research and early commercial development work is being carried out to culture a number of other fish and shellfish species such as turbot, scallops and abalone.

Performance

In assessing the performance of aquaculture in Canada — indeed in the entire temperate zone — comparisons must be made among the current participants rather than with records of the past. Although the basic technology was available in the early 1980s, it was not commercially viable. Circumstances soon changed, however, when fuel price increases, declines in key stocks of some popular wild fishery species and the recognition that eating fish offers significant health benefits combined to make fish farming a commercially competitive possibility. Development started in 1984 and, since 1985, growth has been rapid. The total value of the Canadian aquaculture industry increased from $7 million in 1984 to $62 million in 1987 and to an estimated $156.7 million in 1989 (Table 4).

The growth of salmon aquaculture has been spectacular. Led by Norway, world production of farmed Atlantic salmon grew from 47 800 tonnes in 1985 to 223 000 tonnes in 1989. Canada to a much lesser extent shared in this growth and was also less affected by the backlash in 1989, when market development failed to keep pace with production capability, creating an oversupply on world markets. Prices dropped, in some cases below the cost of production, and charges of dumping and other unfair trade practices were made; in late 1990, some of these cases were still being litigated.

The most significant result of the oversupply, however, was the decision by the major international producers to increase marketing effort rather than to make drastic cuts in production. Because much of that marketing effort will be directed at the development of increased consumption in the United States, Canada should be a major benefactor of this program.

By 1990, most of the industry in New Brunswick had already rationalized itself into a small number of large, relatively financially secure companies and, in addition, the region had inexpensive access to the large northeastern U.S. market.

In British Columbia, where growth had been more rapid and working capital more difficult to obtain, there were several business failures and takeovers. Despite this, however, the number of operating sites dropped only 10 percent from the peak of 150 sites in 1988 to 135 sites in 1990. Financing is still a problem, but the industry has survived and maintains its locational advantage with respect to the U.S. market over Norway, Scotland and Chile, its principal world market competitors.

Shellfish farming also grew during this period, but at a less spectacular and more orderly rate. Capital investment was less than or comparable with that for salmon aquaculture, and operating costs were significantly less.

Estimated Canadian farmed shellfish production in 1989, according to Fisheries and Oceans Canada, was 3 400 tonnes of mussels and 6 300 tonnes of oysters. These figures are expected to double during the next 10 years.

The recent recession may have delayed achievement of full market potential by weak demand conditions and a shortage of funds for investment in market development. However, the aquaculture industry has weathered the normal start-up pressures with some rationalization.

Strengths and Weaknesses

Structural Factors

The overriding structural factor influencing the competitiveness of the Canadian aquaculture industry is Canada's proximity to and understanding of the U.S. market. The United States is not, and is not likely to become, self-sufficient in three of the four aquaculture products (salmon, oysters and mussels) that form the basis of the Canadian aquaculture industry. The fourth Canadian product (trout) is not generally competitive in the American market but has strong sales in Canada.

The Canadian farmed salmon industry has an advantage in shipping costs into the United States relative to Norwegian, Scottish and Chilean competitors. The industry is also able to offer a much higher service level. Freshly harvested New Brunswick salmon can be shipped to New York, and British Columbia salmon can be in California a few hours after being ordered. For shellfish, this advantage is particularly important because the preferred product form is fresh or, in the case of mussels, live, and Canadian producers are well located with respect to major U.S. markets to meet this requirement effectively.

Faced with a choice between surpluses or retrenchment, the major salmon producers have taken an aggressive marketing stance by mounting a major generic campaign to increase salmon consumption. One of the target areas is the American Midwest, one of the biggest underdeveloped fish markets in the world. Because Canadians are very familiar with American lifestyles and understand the American marketing system well, they are likely to be successful in their efforts to compete in that market.

Canada's climate presents some challenges to successful aquaculture development. On the Atlantic coast, except in a limited area around the mouth of the Bay of Fundy, winter water temperatures are too low to permit salmon farming. Until technologies are developed to overcome or bypass the problem, growth of the industry in that region will remain restricted.

On the Pacific coast, water temperatures are high enough to preclude freezing the fish, but some areas that were attractive to the early salmon farmers because of their proximity to transportation services and markets have been abandoned because occasional algae blooms have killed the fish. The remote locations now being developed are safer, but are marginally more expensive to operate.

Because inland water temperatures limit the growth rate for trout, the Canadian industry is uncompetitive in the frozen trout market. Shellfish species chosen for farming in Canada must be able to thrive in the prevailing water temperatures. Therefore, some species such as prawns, which are important in international aquaculture markets, are not farmed in Canada because they require higher water temperatures than are found along the Canadian coastlines.

Other environmental factors that affect water quality also play an important role in determining Canada's competitiveness as an aquaculture producer. Although increased pollution is lowering water quality even in remote areas and although industrial, commercial and recreational developments are taking place on the foreshore, Canada still has sheltered locations with clean water suitable for aquaculture sites and a marine environment as good as any in the world.

Trade factors are less significant. Canadian access to the U.S. market will increase as the U.S. tariffs on processed fish are eliminated under the Canada-U.S. Free Trade Agreement (FTA) which was implemented on 1 January 1989. The success of the multilateral trade negotiations (MTNs) directed at lowering all world tariffs would also enable freer entry to global markets.

Regulations specific to aquaculture within Canada are of minor significance. In some export markets, imported products are regulated more strictly than domestic goods. Such restrictions can lead to delivery delays and, in the case of fresh product, can lead to a serious competitive disadvantage.

Feed accounts for up to 60 percent of the cost of production of farmed salmon. Aquaculturists are anxious to control this cost without sacrificing nutritional value or feed conversion ratios. One approach is to develop husbandry practices that minimize wasted feed. One of the reasons feed ingredients are so costly is that they contain high-quality fish meal, most of which must be imported. Research in the field of fish nutrition may determine more precisely the feed formulation required for the most cost-effective growth.

Waste management is another area of concern, both in husbandry and in processing operations. Managing processing waste presents the same challenge, whether the fish are caught wild or raised on a farm. Programs are in place to develop cost-effective methods for handling processing waste in an environmentally acceptable fashion. For example, although waste accumulating under cages has been cited as a potential problem, damage has not been substantiated in practice. Profitability of husbandry practices depends on site selection, cage design, stock density and water flow through the facility to keep the area clean.

The most challenging waste disposal problem for a salmon aquaculturist is how to deal with dead fish. Some fish mortality is inevitable and, even in a well-run farm, the numbers can be significant. Fish meal plants will not accept the dead fish because they automatically assume that they are

diseased and will contaminate their products. Landfill sites are limited, and their operators are reluctant to accept fish waste of any kind. Research is being conducted to develop acceptable means of treating this material.

Trade-Related Factors

There are no tariffs on unprocessed aquaculture products traded with the United States, the market for over 70 percent of Canadian aquaculture production, and tariffs are not expected to be a critical factor in trade with other countries.

Some practices, however, may be considered as non-tariff barriers (NTBs). In the United States, for example, all fish are subject to the same standards, but submission of domestic production for inspection is voluntary. This practice can put imported product, which is regularly inspected, at a disadvantage both in terms of detention time and application of standards.

Technological Factors

Successful aquaculture depends on leading-edge technology in many fields such as improved husbandry, disease and predator control, feed development and conventional selective breeding. Few, if any, of these are unique to Canada and therefore do not compromise Canada's competitive position. However, biotechnology and genetics will play an increasingly important part in the development of aquaculture. For example, growth of the Atlantic coast salmon industry beyond the capacity of existing sites is limited by the problem of lethal winter water temperatures. Engineering or biotechnology innovations that are both technically feasible and economically viable may provide the solution.

Often, the results of research, much of it conducted in Norway, are not readily accessible; even the results of non-competitive work are disseminated slowly. This transfer of information is an international problem not peculiar to Canada. Canada is attempting to form an international network or consortium wherein those who are engaged in non-competitive or precompetitive research will be able to communicate more effectively with one another.

The development of further processed products is both a technological and a marketing issue. Further processing can lead to increased profit both from the higher value-added content of such products and from the improved market access gained by offering consumers a broader range of product choices to fulfil their needs. Farmed and wild-caught fish share these opportunities, and development potential exists for both. The strategy of the Canadian industry, particularly on the Pacific coast where salmon aquaculture and wild fisheries co-exist, is to integrate the two, drawing on whichever fish best matches an opportunity. Most aquaculture fish are directed to the fresh market, where they realize higher returns from investment in more effective and efficient systems for delivering high-quality fish to market as quickly as possible after harvest.

As supplies of farmed fish increase, more product will need to be in a more highly processed form. Processing not only will use up surplus fresh fish, but also will increase demand among new consumers who are unfamiliar with, and frequently uncomfortable with, the preparation of unprocessed fish. Processed oyster and mussel products are also being marketed more actively.

Associated product and package development programs are more advanced in Europe than in Canada. Although technology transfer and joint venture opportunities are available for Canadian companies, leadership in the market will require an increased level of market-driven product development by Canadian companies.

Other Factors

Environmental factors are important to aquaculture, both in terms of how aquaculture affects the environment and how it is affected by the environment.

In addition to the need for clean water, sheltered sites and appropriate climatic conditions, consideration in this age of environmental consciousness must be given to the way a fish farm affects its environment and the steps required to mitigate any negative effects. Challenges can arise from algae blooms and competing uses for the water sites such as recreation. These problems can be mitigated by proper siting and management.

One potential, but not serious, threat to industry development in Canada has been the fear of other segments of the fishery industry that aquaculture may threaten their livelihood. For example, many of the aquaculture pioneers in Canada were regular fishermen looking for a better living. In New Brunswick, preference in allocating aquaculture licences initially was given to fishermen. In British Columbia, the old, established salmon companies provided marketing services and, in some cases, working capital loans to the new farmers. Eventually, through development or acquisition, these companies became part of the aquaculture industry themselves. The integrated marketing that resulted from this move benefited both wild and farmed salmon stakeholders.

In Alaska, by contrast, salmon farming has been forbidden by law in order to protect the wild salmon industry. The rationale for this law is twofold: escaped farm-raised salmon may mate with and weaken the genetic integrity of the wild species, and farmed salmon, which is more susceptible to disease, could infect wild stocks. These factors have been considered and judged not significant by Canada and all other salmon-farming countries.

A shortage of investment capital and a lack of access to working capital loans have hampered the growth of salmon aquaculture in Canada, thus contributing to the failure of some companies and the foreign takeover of others. This situation will improve as the industry matures and as large, established Canadian companies begin to participate. Proposed amendments to the *Bank Act*, if passed, will allow live fish inventory to be pledged as security and will also ease the pressure on working capital.

Evolving Environment

Aquaculture is a developing industry, and the rate at which it develops will depend on both internal and external factors. Internal factors to be addressed are husbandry, cost of production, quality, marketing and management skills.

The critical external factors are interest rates as well as the availability of investment capital and competent management and technical personnel. Many of the problems encountered during the early days of the industry are attributable to underfinancing, unwise management decisions and inadequate technical knowledge.

Feed represents the largest element of aquaculture production costs. As aquaculture production expands, its fish meal requirements will also rise. Without increased supplies, aquaculture will need to compete for feed with the poultry and hog industries, a circumstance that could drive up fish meal prices. Exploitation of small pelagics, which produce a fish meal that is popular with salmonid aquaculturists because it is rich in oil, is close to its limit. Feed manufacturers in British Columbia have already been experiencing shortages in the local supply of high-protein meal, which has led them to search out competitively priced anchovy meal from South America.

The FTA will have a positive effect on the aquaculture industry, and the expected results of the current MTN round are potentially positive. Tariff reductions for processed fish products would have a positive effect, as would the removal of NTBs that interfere with access to some markets.

The economic integration of Europe after 1992, particularly if Norway joins the European Community (EC), will place a key competitor inside the protection afforded by the EC and make sales to the European market more difficult for Canada. However, this will not affect the U.S. market, where most of the Canadian product is sold.

At the time of writing, the Canadian and U.S. economies were showing signs of recovering from a recessionary period. During the recession, companies in the industry generally experienced reduced demand for their outputs, in addition to longer-term underlying pressures to adjust. In some cases, the cyclical pressures may have accelerated adjustments and restructuring. With the signs of recovery, though still uneven, the medium-term outlook will correspondingly improve. The overall impact on the industry will depend on the pace of the recovery.

Competitiveness Assessment

To be competitive, Canada must have a reliable supply of consistently good-quality product that offers good value in comparison with other fish products and other protein foods. The success of the Canadian industry will depend on how well it meets the requirements of other farmed salmon producers in Norway, Scotland, Ireland, Chile and, more recently, New Zealand.

Norway is by far the world's largest farmed-salmon producer today, and it is likely to remain so for some time. Because Norway is located as close to Europe as Canada is to the United States, Norwegian salmon will probably dominate the European market, except where the Pacific salmon species is preferred. If Norway becomes a member of the EC, market development there by outside producers will be even more difficult.

Although Canada has the locational advantage in the U.S. market, the inland portion of the market is not well developed. It does, however, have the potential to absorb more product than Canada alone could provide. In fact, both Norway and Chile are already selling salmon in the United States, and it is probable that the market will be shared by the three countries.

Major competitors from Norway and Scotland have been more successful than Canadians in generating the private sector funds required to engage in significant generic export market promotion. Some Canadian producers are following suit. Only recently have Pacific coast salmon fishermen placed a levy on wild salmon catches to promote marketing of salmon from the west coast industry through their association.

It is important to note that Canada also shares its locational advantage to the U.S. market with a small number of domestic U.S. salmon farmers. This could change if Alaska repeals its ban on salmon farming, although the impact would not be felt in the market for at least three years. Of more immediate concern to Canadians is the development by U.S. catfish farmers of a market for their product; they will become strong competitors for a share of any market growth.

Another large salmon market is Japan. Japan has traditionally favoured the Pacific salmon species and, although its own domestic farming industry raises coho salmon, it lacks the

capacity to satisfy the demand. British Columbia farmers who farm Pacific salmon species will have a locational advantage in Japan, but Chile also is able to deliver coho salmon to Japan, and Norway is now promoting Atlantic salmon there. Chile has lower production costs than Canada because its anchovy fishery provides large quantities of inexpensive fish meal. Chile can therefore be expected to compete aggressively in Japan and in the western United States.

New Zealand has established a salmon aquaculture industry, and is a competitor in the Japanese market. Although Scotland and Ireland have well-established salmon farming industries, their marketing efforts have not been directed at the North American market, where Canada's best opportunities appear to be.

For further information concerning the subject matter contained in this profile or on the ISTC sectoral studies and initiatives listed on page 12, contact

Food Products Branch
Industry, Science and Technology Canada
Attention: Aquaculture
235 Queen Street
OTTAWA, Ontario
K1A 0H5
Tel.: (613) 954-2931
Fax: (613) 954-3107

MAJOR FIRMS

Name	Country of ownership	Location of major sites
Atlantic Silver Co-op Ltd.	Canada	St. George, New Brunswick
British Columbia Packers Limited (Weston)	Canada	Richmond, British Columbia
Connors Bros., Limited (Weston)	Canada	Blacks Harbour, New Brunswick
General Sea Harvest Canada Ltd.	Finland	Surrey, British Columbia
P.E.I. Mussel Farms Inc.	Canada	Morell, Prince Edward Island
Pacific Aqua Foods Ltd. (includes interest by National Sea Products)	Canada	Brougham Point, British Columbia Horn Point, British Columbia Port Hardy, British Columbia Thurlow Point South, British Columbia Vancouver, British Columbia
Redonda Sea Farms Ltd.	Canada	Vancouver, British Columbia
Scanmar Seafoods Ltd.	Norway	Saltery Bay, British Columbia
Sea Farm Canada Inc.	Canada/Norway	Campbell River, British Columbia Sussex, New Brunswick

INDUSTRY ASSOCIATIONS

Aquaculture Association of Canada
P.O. Box 1987
ST. ANDREWS, New Brunswick
E0G 2X0
Tel.: (506) 529-4766
Fax: (506) 529-4274

British Columbia Aquaculture Research
and Development Council
Suite 506, 1200 West Pender Street
VANCOUVER, British Columbia
V6E 2S9
Tel.: (604) 683-3387
Fax: (604) 669-6974

British Columbia Salmon Farmers Association
Suite 506, 1200 West Pender Street
VANCOUVER, British Columbia
V6E 2S9
Tel.: (604) 682-3077
Fax: (604) 669-6974

British Columbia Shellfish Growers Association
c/o Mac's Oyster Limited
Attention: Mr. Gordon McLellan
R.R. 1, Site 7, Compartment 2
FANNY BAY - Vancouver Island, British Columbia
V0R 1W0
Tel.: (604) 335-2233
Fax: (604) 335-2065

Canadian Aquaculture Producers' Council
P.O. Box 1058
SHEDIAC, New Brunswick
E0A 3G0
Tel.: (506) 532-2320
Fax: (506) 532-8568

New Brunswick Salmon Growers Association
R.R. 4, Limekiln Road
ST. GEORGE, New Brunswick
E0G 2Y0
Tel.: (506) 755-3526
Fax: (506) 755-6237

P.E.I. Cultured Mussel Growers Association
c/o Atlantic Mussel Growers Corp. Ltd.
Attention: Mr. Wayne Somers
P.O. Box 70
MURRAY RIVER, Prince Edward Island
C0A 1W0
Tel.: (902) 962-3089
Fax: (902) 962-3741

SECTORAL STUDIES AND INITIATIVES

The following publications are available from the nearest Business Service Centre (see inside front cover).

Bibliography of Recent Aquaculture Publications
This compilation was prepared by the Seafood and Marine Products Directorate of ISTC in September 1990.

Salmon Aquaculture: A Report on the Canadian Industry
This publication provides information on the development and characteristics of Canada's salmon aquaculture industry.

The following initiatives have been recently supported by Industry, Science Technology Canada.

In 1990, ISTC launched a seafood and marine products sector campaign, which included aquaculture as one of its four major thrusts. Sector campaigns are joint initiatives by ISTC and Canadian industry to improve the long-run international competitiveness of industrial sectors. Key obstacles to improved competitiveness will be identified and activities selected and funded jointly by industry and government will be implemented.

In 1990, ISTC also instituted the Competitiveness Analysis Framework (CAF). The purpose of the CAF is to provide a consistent framework for ISTC in assessing the competitiveness of Canadian industries. The Industry and Technology Sector within ISTC and the Industrial Competitiveness Branch in the Policy Sector have agreed to undertake a pilot application of the CAF to fish processing and two other industries and to finance the project from the sector campaign fund. A pilot application including fish processing was undertaken in 1990–1991.

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