

AQUACULTURE AND THE EXPORT OF KNOWLEDGE-BASED SERVICES

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THE NORTH ATLANTIC ISLANDS PROGRAMME

Lessons from the Edge: The North Atlantic Islands Programme is a project of the Institute of Island Studies at the University of Prince Edward Island, Canada, in association with NordREFO, the Nordic Institute of Regional Policy Research, based in Stockholm, Sweden.

The purpose is for seven islands of the North Atlantic -- the Åland Islands, the Faroe Islands, Greenland, Iceland, the Isle of Man, Newfoundland and Prince Edward Island -- to identify public policy proposals aimed at greater economic self-reliance for small jurisdictions.

Using a comparative framework, the Programme examines historical and contemporary challenges and opportunities of the seven islands included in the research. All share common problems of very small size, relatively peripheral location, changing relationships with metropolitan centres and daunting challenges of adjustment in a time of greater globalization. However, with an increasing reliance on telecommunications, the barriers of geography and distance have become almost incidental, and very small size may in fact suggest openings and niches with returns for small economies. Identifying and targeting such niches has already been a hugely profitable strategy for many of the world's most successful small jurisdictions. It is in examining these success stories that we hope to find "lessons" that can be adapted to suit these small islands of the North Atlantic.

Programme Objectives

The North Atlantic Islands Programme has three major components:

- creating a common statistical database;
- comparing the jurisdictional arrangements in the seven islands; and
- sectoral research comprising four main sectors:
 - Resource-based Industries, including fisheries, aquaculture and agriculture;
 - Small-scale Manufacturing;
 - Tourism; and
 - Export of Knowledge-based Services.

The research is just the beginning. The main thrust of this exercise is to explore and encourage new ways of thinking resulting in initiatives on the ground, in the public policy arena, and above all, among island business ventures. Exchange programmes, trade missions, joint ventures and apprenticeship and training projects are all integral to both the mandate and the execution of this Programme.

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The Study-Apprenticeship Programme

One such initiative is the Study-Apprenticeship Programme sponsored by the Province of Prince Edward Island and the North Atlantic Islands Programme. Carolyn Gillis, the author of this report, is the Programme's first participant, with a placement in Iceland where she is currently studying and working in aquaculture. Carolyn is a native of Montague, Prince Edward Island, and has a Master's degree in aquaculture from Memorial University of Newfoundland. Before leaving for Iceland, she undertook a six-week preliminary study of aquaculture and some related opportunities for the Export of Knowledge-Based Studies. The following report combines two of the fastest-growing industries in the Atlantic provinces -- aquaculture and the export of knowledge -- and provides, we hope, a starting point for new initiatives.

The Institute of Island Studies gratefully acknowledges the financial assistance of the Province of Prince Edward Island and of Human Resources Development Canada.

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INTRODUCTION

When asked to prepare a paper on the Export of Knowledge-based Services in the Aquaculture sector of Atlantic Canada, my initial thought was "What does that mean?" In exploring this concept, I began by looking at the aquaculture industry in Canada, and then focused on Atlantic Canada and how it relates to world aquaculture production.

My next step was to determine what is meant by knowledge-based services. From looking through literature on the topic, I found what appears to be an abundance of different meanings and usage for "knowledge-based" depending on what discipline you are examining. It does seem to be the new buzzword in economic circles! As one might assume, much of the literature deals with computers and associated knowledge or the economics involved with such an industry. I came across two papers, however, which I thought generally explained the concept and how it fits into society in general. I have summarized these papers, largely verbatim, since the authors can explain what they mean much better than I.

Next I looked at the aquaculture industry in each of the provinces in greater detail, with the primary focus being on Prince Edward Island, since I had more access to information and greater ability to meet with key players in the aquaculture industry. I have listed aquaculture training facilities, which play a vital role in the sector of knowledge-based services, suppliers of technical

assistance, aquaculture associations and business/consulting companies, specializing in aquaculture. The list I have compiled should in no way be considered exhaustive, but rather a general overview of existing and potential candidates for the export of knowledge-based services.

I then examined the role of government in aquaculture development. This section deals primarily with the federal government departments involved, whereas provincial departments are examined in the sector "The Aquaculture Sector in the Maritime Provinces."

Due to the importance of international development in this sector, I have examined the role and finances involved in external aid and means for Atlantic Canadian ventures to market their services internationally.

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AQUACULTURE: PAST, PRESENT AND POTENTIAL

Today more than half of the world's population relies on fish as a principal source of animal protein. However, the world population is expected to grow from the present level of approximately 4 billion to about 7 billion by the year 2000. Fish production will need to almost double its present level of catch (approximately 70 million tonnes) by the year 2000 in order to supply the need.

A basic characteristic of ocean fisheries is that they deal with a natural resource that is common property. Therefore, there is no incentive to prevent a nation or individual from over-exploiting the fishery; if they don't catch it, someone else will. Over-exploitation of many fish species has occurred, resulting from:

- lack of efficient management schemes;
- increased fishing efforts; and
- improved fish-finding and fish-catching devices.

The maximum sustainable harvest on conventional species from the sea is estimated to be as low as 100 million tonnes (Shang, 1981). Other events undermining fisheries potential are:

- steep increase in fuel costs;
- increase in marine pollution;
- decrease in fishery production by countries depending on fishing in foreign waters, as a result of extension of exclusive fishing zones by nations; and
- the need in some areas to relocate and find alternative additional employment for excess fishermen and underemployed farmers.

All these factors have resulted in an increased focus on aquaculture: the rearing of aquatic organisms under controlled conditions.

Shang (1981) suggests that aquaculture has the following advantages over conventional fishing and agriculture:

- Fish culture is stock raising, as opposed to hunting, resulting in more efficient use of energy and time. As well, the harvest is proportional to effort and can be predicted.
- Environmental conditions can be largely controlled and genetics can be manipulated to improve yield.
- Exclusive rights to a resource can usually be established and international agreement is usually not necessary (an exception being salmon ranching).
- Aquaculture can be conducted on land not suitable for agriculture (for example, where waters are saline or brackish).
- Fish require minimum metabolic energy for the maintenance of their body temperature and normal locomotion. This means that they are more efficient converters of food. As well, many species can grow well on nutrients from natural aquatic environments (e.g., mussels).

Conversion rates of dry feed to wet weight gain:

Fish 1.5 to 1.0 or less

Cattle 10.0 to 1.0

Hogs 4.0 to 1.0

Poultry 2.5 to 1.0

- Fish use space more efficiently than many land animals. For example, in well-managed environments, 3,000 kg or more of fish can be produced per hectare per year, as opposed to the maximum figure for cattle of 500 to 700 kg.
- Market demand for fish in aquaculture facilities can be expanded much easier than the demand for wild fish. Fish farmers can guarantee delivery of a certain amount and quality. Fish farmers can also control production and market their stock when natural supplies are either seasonally low or unavailable for other reasons.
- Aquaculture offers possibilities for species' improvement by selective breeding to meet consumers' tastes and market requirements.
- Aquaculture can become a major income-generating element in integrated rural development programs. It is estimated that the production of every 4 tonnes of fish requires one full-time job. Culturing valuable species for export contributes to foreign exchange earnings. Bait fish production can contribute to the development of commercial and/or sport fishing and sea farming can help to build future fishery resources or enhance existing stocks.

Contribution That Aquaculture Has Made to Availability of Global Food Resources (Boghen, 1995):

Year	Production (tonnes)	Value (\$ billion US)
1967	approx. 1 million	
1980	8.7 million	
1984		12
1988		24
1992	19.3 million (including aquatic plants)	32.5
1993	21 million	

Production levels of global fisheries, over the next decade, are expected to stabilize in the range of 85 to 100 million tonnes. Stechey *et al.* (1995) point out that wild fishery catches have peaked at approximately 100 million tonnes in recent years and have begun to decline. The majority of the world's 17 major fisheries are in serious decline. Four are classified as commercially depleted and the others are either fully exploited or over-exploited.

Changes in World Production of Fisheries and Aquaculture for the Years 1987 to 1992

Source	1987	1988	1989	1990	1991	1992
	MMT	MMT	MMT	MMT	MMT	MMT
			%	%		
Capture Fishery	94.4 -	99.0 - 4.9	100.0 - 1.2	97.4 - [2.7]	96.6 - [0.8]	85.0 - [12.0]
Aqua-culture	13.2 -	14.5 - 9.8	14.4 - [0.7]	15.3 - 6.3	16.6 - 8.5	19.3 - 16.3
(all spp.)	(12.3)*	-12.8	-12.6	-13.6	-14.7	-18.5
TOTAL	107.6	113.5	114.6	112.7	113.2	104.3

MMT = million metric tonnes % = per cent increase with reference to previous year; [] = decrease

* = aquaculture production as percentage of total fisheries harvest (includes capture fisheries and aquaculture)

In 1992, of the 12 countries that accounted for more than 90% (17.2 million tonnes) of total production, ten were Asian. Six Asian nations produced 81% of all cultivated resources: China, Japan, India, South Korea, the Philip-pines and Indonesia. China alone accounted for more than

54% of world aquaculture production (10.4 million tonnes), although this figure represents only 35% (US \$11.5 billion) of total world value.

Shang (1981) suggests that world aquaculture production in 1975 was estimated to be over 6 million tonnes in 60 countries. This was approximately equal to 10% of the world fish production. Finfish production was the most important part of aquaculture and accounted for about 65% (4 million tonnes). Major countries producing finfish (in order of importance) were: China (excluding Taiwan), India, USSR, Japan, Indonesia, Philippines and Taiwan. Carp and milkfish were the two major species produced in fresh and brackish waters, respectively.

Molluscs accounted for approximately 17.2% of the total aquaculture product (1 million tonnes). Major producing countries were Japan and the United States for oysters, Spain and Italy for mussels, Korea and Taiwan for clams, Japan for scallops and Malaysia for cockles.

Seaweeds accounted for approximately 17.3% of production (1 million tonnes). The main producers were Japan, China and Korea.

Shrimps and prawns accounted for approximately 0.3% of total production (16,000 tons), and the primary producers were India, Indonesia, Thailand and Japan.

In total, Asia accounted for about 81% of the total world production.

Webber and Riordan (1976) suggest the following projected aquaculture potential. There are approximately 440 million hectares in the world, mostly mangrove swamps in the tropics. If only 10% of these were used for aquaculture, even using the lower productivity techniques of the traditional subsistence farmer, 100 million tonnes of aquafoods would be produced.

World aquaculture-producing nations fall into two categories: (1) those producing aquaculture products primarily for domestic consumption, such as Japan, China, India and Taiwan; and those producing products for export, the main ones being Canada, Norway, Chile and Scotland. Export-producing countries tend to employ high-technology culture methods, produce species of high economic value and tend to be dominated by large, private-sector firms, utilizing high-volume and high-quality market production strategies (Federal/ Provincial Aquaculture Working Group, 1994).

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THE CANADIAN PERSPECTIVE

In 1992, North America's total harvest, including aquatic plants, was approximately 2.5% (485,246 t) of world production. Canada's contribution was less than 0.2% (30,852 t), placing it 29th in the world. Total value (approx. US \$146 million), however, resulted in a ranking of 24th.

In 1986, Canada's production in aquaculture was approximately 8,000 tonnes at a value of about CAN \$35 million. In 1993, Canada's production had risen from 45,000 to 50,000 tonnes, at a value of almost \$300 million for farm-gate prices alone.

In 1993, Canada's total output equalled 50,201 tonnes, having a farm-gate value of \$289 million. Since 1984, Canada's aquaculture industry has grown at an annual rate greater than 67%. In 1991, 75-80% of the total production and 20% of supplies and services were marketed outside Canada, bringing more than \$245 million into the economy.

The following projections (DFO status report: "Aquaculture in Canada") are based on consultations with stakeholders, and suggest a sector growth rate from 1991-2000 of 11.3%, which is a realistic and sustainable rate through this period.

Industry Value (\$ millions)

	1984	1991	2000
Farm-Gate Production	7	256	677
Supply & Services	-	266	560

Industry Employment

	1984	1991	2000
Production Employment	<200	2825	8125
Services Employment	-	2355	4100

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THE AQUACULTURE SECTOR IN ATLANTIC CANADA The species with the greatest value in Atlantic Canada include Atlantic salmon, blue mussel, American oyster and, to a lesser extent, freshwater rainbow trout and steelhead trout.

In addition to these species, there is a second group about which there is substantial information but which have shown inconsistencies in production levels and values over the last two to five years. These include European (Belon) oyster, sea and bay scallop, Arctic charr, quahaugs, Irish moss and cod.

A third category consists of a variety of species that are being considered as potential candidates for aquaculture. This category includes the bar (surf) clam, soft-shell clam, Atlantic halibut, striped bass, yellowtail flounder, wolffish, winter flounder, haddock, lumpfish and eels. There is also continuing interest in the culture of lobsters, although previous efforts have met with little success.

Although the potential for aquaculture development is great, expansion requires extensive research in biological and technical aspects; acceleration in the transfer of technology; adequate support in credit, training, extension and other essential infrastructures; and appropriate environmental and legal management policies.

Estimates for Commercial Aquaculture Production in Atlantic Canada in 1993

Province	Species	Weight (t)	Value (\$000s)
New Brunswick	Atlantic salmon	10,145.0	892002760553112
	Brook/Rainbow trout	314.0	
	American oyster	201.0	
	Blue mussel	102.0	
Newfoundland	Atlantic salmon	100.0	71375335614728
	Steelhead trout	113.0	
	Arctic char	12.0	
	Cod	5.3	
	Blue mussel	209.0	
	Scallop	2.0	
Nova Scotia	Atlantic salmon	443.0	3,037
	Steelhead/Rainbow/	192.0	1,030
	Brook trout	49.5	132
	American oyster	292.0	303
	Blue mussel	349.0	450
	Bay/Sea scallop		
	Clams		
Irish moss			

	European oyster	
	Arctic charr	
Prince Edward Island	Atlantic salmon	- 33
	Rainbow/Brook trout	34.3 240
	Arctic charr	14.5 166
	Blue mussel	4540.0 4994
	American oyster	1078.0 1973
	Bay scallop	0.5 3

PRINCE EDWARD ISLAND

The fishing industry in Prince Edward Island produces \$200 million worth of direct and indirect benefits and employs 7,900 people in fish production and processing (contributed 35-40% of the province's revenue from inter-national exports). Lobster is the lead subsector, with landings valued at \$48 million (72% of total value of the fisheries sector).

In 1978, commercial mussel production in Prince Edward Island was non-existent, but increased between 1980 and 1986, when 30 active farms harvested approximately 800 tonnes (t), bringing in a revenue of \$1.5 million (Day, 1989). Mussel production in 1991 rose by 26% to reach a record of 7.5 million pounds, with a value of \$3.7 million (6% of the province's fishery output).

Oyster production in Prince Edward Island has tripled in the past 15 years, jumping from more than 600 t in 1973 to more than 1,800 t in 1986. In 1987 more than 1300 t of oysters were harvested (Day, 1989). Oyster landings were down to 2.7 million pounds in 1992, with a value of \$1.9 million (3% of the fisheries sector). Oyster production in 1995 was between 3.5 million and 4 million pounds, making it the second highest production year this century. About 15-20% of total production came from leases, with the remainder from the public fishery. There were 400 active oyster license holders and 100 active lease holders (*The Guardian*, March 4, 1996).

Total sales in finfish culture rose in 1991 and there was an increased sale of hatchery products. New developments involve the culture of quahaugs, scallops, Arctic charr, eels and striped bass.

The combined value of landings of oyster, mussels, quahaugs, scallops, bar clams and soft-shell clams exceeds \$11 million annually and provides source of income to nearly 2,000 people.

Finfish culture in Prince Edward Island is composed of three types of operations:

- Certified hatcheries maintain broodstock and supply fingerlings as starter stocks for meat producers and fee fish operators both on Prince Edward Island and for export. Island hatcheries are producing stocks of rainbow and speckled trout, Arctic charr and Atlantic salmon.
- Island meat fish producers culture fish to sizes at which they can be processed and sold for consumption, both locally and for export. In 1991, rainbow trout and limited amounts of Arctic charr and Atlantic salmon were grown.
- Fee fish operators allow customers to catch fish in stocked ponds and to purchase the catch. Rainbow and speckled trout are both grown for fee fishing, although most operations are moving toward the use of rainbow exclusively.

Approximately 40 persons are employed, either full-time or part-time, in the 20 finfish culture installations.

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NEW BRUNSWICK

Between 1979 and 1984, salmon production increased from 6 t to more than 200 t, with a value going from \$49,000 to \$2.5 million (Day, 1989). Reports on the 1987 harvest showed that 32 privately owned farms are operating in the Bay of Fundy. These produced more than 1,300 t of Atlantic salmon for a value of more than \$18 million. As well, the price per pound almost doubled between 1979 and 1987.

NOVA SCOTIA

Salmon aquaculture production is smaller than in New Brunswick but has begun to produce considerable amounts of cage-reared Atlantic salmon, particularly in Cape Breton and along the southeast shore. In 1987, there were ten commercial farms in the province, with a harvest of 37 t. Of the 60 mussel farms in the province, 12 are large-scale operations. There was a total production of 257 t blue mussels in 1987, with a value of \$430,000 (Day, 1989).

NEWFOUNDLAND

The following information concerning Newfoundland's aquaculture industry is from "Aquaculture: Growing Opportunities," a paper prepared by a federal/provincial Aquaculture Working Group in 1994. Newfoundland produces only 0.6% of Canada's aquaculture output and its progress lags behind that of the other provinces in Atlantic Canada. In 1993, there were 53 commercial aquaculture enterprises in Newfoundland. There were an additional 44 developmental licenses issued for evaluation of site and species. The aquaculture industry produced 463 t valued at \$1.7 million.

Mussel production went from a high of 300 t in 1990 to 160 t in 1992. There are about 8 million sea scallops for sale.

Potential for Atlantic salmon aquaculture exists, however, as evidenced by the fact that the Bay d'Espoir estuary is approximately four times the area currently used in New Brunswick to produce in excess of \$100 million in annual sales. As well, there are only two commercial fish-out facilities for freshwater rainbow trout. The absence of certified hatcheries to provide pond stock is a major impediment. Arctic charr is cultured by one commercial operator supplying local markets. Major impediments to charr culture include fry survival and pigmentation.

Atlantic cod culture is dependent on a supply of wild fish for a starting stock so commercialization is stalled until recovery of wild stocks, or development of economically suitable hatchery production.

Industry suggests that production could increase to 28,800 t by the year 2000. To determine true financial viability of aquaculture ventures for the investor, the government incentives and other financing decisions are removed, to determine the Internal Rate of Return (IRR). Internal Rate of Return (IRR) is the interest rate which equates further financial returns to the initial investment. A higher IRR indicates a better investment opportunity. Given the inherent risk associated with aquaculture, potential investors are likely to require an IRR in excess of 20%.

Of the species currently being cultured commercially in Newfoundland, steelhead trout was found to have the highest IRR (17%), followed by Atlantic salmon (13%), mussels (13%), Atlantic cod (10%) and scallops (3%). The paper goes on to suggest that progress must be made on identifying and developing "sustainable competitive advantages," which improve a company's cost of doing business and are available over the long term, but not available to the company's competitors. Examples may include availability of capital, availability of food and support industries and services.

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THE AQUACULTURE SECTOR IN THE MARITIME PROVINCES

INTRODUCTION

The information in this section has been gathered from various sources. Some of the information on educational facilities, technical assistance and aquaculture associations is from Day (1989). Much of the information on consulting companies is extracted from a report by Mohr (1995), entitled *Aquaculture in Atlantic Canada*. As well, some information was taken from a report prepared by the Atlantic Veterinary College (1989), entitled *Aquaculture Resource Agency Directory: Prince Edward Island*. Literature was also provided by various agencies involved in aquaculture.

In addition, I would like to thank the following people who spared the time to discuss with me their aquaculture endeavours:

- **GERRY JOHNSON**
Atlantic Veterinary College
- **BOB JOHNSTON**
Canadian Aquaculture Institute
- **GERALD ARSENAULT**
Atlantic Fish Health, Inc.
- **ALLAN MORRISON**
Prince Edward Island Department of Agriculture, Fisheries and Forestry
- **SHELLEY CLARK**
Enterprise PEI
- **DAVID COOK**
Atlantic Canada Opportunities Agency
- **DAVID CAIRNS**
Prince Edward Island Department of the Environment
- **FRASER DICKSON**
Industry Canada
- **SANDY HEIGH**
Hidden Valley Charr
- **SEFTON DIXON**
Atlantic Sea Smolt Ltd.
- **TOM O'ROURKE**
National Research Council
- **GARY STAIRS**
New Brunswick Department of Environment and Disasters

The information included here is by no means meant to be an exhaustive study of all the aquaculture-associated endeavours in the Maritimes, but instead is intended to provide an overview of the types of services available.

PRINCE EDWARD ISLAND

V.1.1

AQUACULTURE EDUCATIONAL FACILITIES

Atlantic Veterinary College (AVC), University of Prince Edward Island The following units of AVC perform aquaculture-related work:

- *Farm Service and Health Management (service and education)*
These clinicians regularly visit finfish and shellfish farms, to monitor health and production, and to respond to disease outbreaks. Technical and computer resources are used to support the integration of production and health records for ongoing farm management or disease investigation. Costs are covered through the College's operating budget, provincial contracts and charges to producers on a fee-for-service basis.
- *Fish Health Diagnostic Service (diagnostics)*
AVC provides a wide range of diagnostic services to the aquaculture industry and fish health professionals in Atlantic Canada, nationally and internationally. AVC is one of

only a few centres in the world able to provide fully integrated fish health services. This Unit has generated over \$85,000 per year for the last five years. There is a proposal for creating a self-contained, self-sustaining Fish Health Diagnostic Service at AVC.

- *Canadian Aquaculture Institute (CAI) (continuing education)*

This is a joint initiative of the University of Prince Edward Island and Holland College, and is based at the Atlantic Veterinary College. Its objective is to assist aquaculture throughout the world through the development and delivery of training courses in aquaculture medicine, fish health and management to veterinarians, fish health scientists, fish farm managers, aquaculture technicians, researchers, government officials, investors and others. Many of the courses are offered at AVC but will respond to the needs of the industry by offering training in other locations across Canada and around the world. Courses offered include topics such as Financial Decisions in Aquaculture, Fish as Research Animals, Basic Disease Diagnostics in Finfish Aquaculture, Bacterial Diagnostics in Finfish and Shellfish Aquaculture, Prescription of Aquaculture Therapeutics, and Applied Aquaculture Epidemiology.

CAI operates an Internet list, Aqua-L, to promote discussion among individuals interested in the aquaculture industry, and has subscribers in 26 countries. CAI was developed with assistance from the Max Bell Foundation and the PEI/Canada Cooperation Agreement on Strategic Technology Acquisition.

- *Aquatic Animal Facility*

This Unit is operated by Animal Resources and provides controlled environments for fresh-water and marine finfish and shellfish, at temperatures just above 0C to over 30C. Industry and other institutions use the facility for research. The staff provide assistance in design and implementation of research projects, as well as consultation for design and maintenance of aquatic holding systems. It is funded on a fee-for-service basis.

- *Atlantic Fish Health, Inc. (AFHI) (research)*

AFHI is an incorporated, for-profit company, wholly owned by the University of Prince Edward Island. AFHI's major focus is drug evaluation research, biochemistry and toxicology research, veterinary pathology, parasitology and microbiology research, diagnostics and water quality analysis for the aquaculture industry. These services are marketed to pharmaceutical companies, aquaculture and other fish-related industries or institutions. AFHI is one of the few companies in the world that can provide fully integrated fish health services. AFHI is interested in joint ventures with national and international fish health related companies and/or institutions that require technical and veterinary expertise in disease, health and environmental controls.

- *Holland College*

Holland College offers an Aquaculture Training Program. This consists of a one-year program for Finfish Technicians, as well as a second optional year for Finfish Grower Profile, which enables a person to operate or manage a finfish operation. There is also a one-year program for the Shellfish Technician Profile, again with a second optional year which enables a person to operate or manage a shellfish operation. Generally, this program deals with practical and theoretical sides of raising mussels, oysters, quahaugs, rainbow trout and salmon. Subject areas include fish and shellfish physiology, health and

nutrition, operation and maintenance of facilities, shellfish culture techniques, and financial and business management.

Holland College has a record in international education and has participated in the conduct of feasibility studies, project management and evaluation, curricula development in Africa (Swaziland, Kenya, Nigeria, South Africa), Asia (China, Pakistan), Latin America (Peru) and the Caribbean (Belize).

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V.1.2

TECHNICAL ASSISTANCE

Prince Edward Island Department of Agriculture, Fisheries and Forestry

The Aquaculture Branch of this department is responsible for providing research, technical and financial support for development of the aquaculture industry in Prince Edward Island. It works with the Department of Fisheries and Oceans in the development and management of aquaculture, and has technical and administrative capabilities in such areas as aquaculture strategy preparation, funding for aquaculture, oyster enhancement, aquaculture diagnostic services, mussel culture, finfish culture, clam culture, scallop culture, shellfish seed supply, shellfish depuration and the culture of other species.

The Aquaculture Branch administers the following assistance programs designed to provide financial support to aquaculture development:

- Mussel Production Expansion Incentive Program;
- Finfish Production Expansion Incentive Program;
- Aquaculture Loan Program;
- Aquaculture Crop Insurance Program;
- Mussel Sandbag Substitution Program; and
- Aquaculture Technology Development Program.

Department of Fisheries and Oceans (DFO)

In Prince Edward Island, DFO is responsible for issuing leases to practice aquaculture, leases to occupy crown lands and overall management. It assists the province in providing development and management support to the aquaculture industry and maintains the Eilerslie Research Station in Prince County, Prince Edward Island.

Enterprise PEI

Enterprise PEI will provide the following to the aquaculture industry:

- marketing research;
- marketing tests and plans;
- promotional tools;
- trade show participation and organization;
- research, in conjunction with ACOA, for example;

- business plan development; and
- financial assistance in such areas as capital costs, rental initiatives, etc.

One difference in financial assistance offered by Enterprise PEI, as opposed to ACOA, is that financial assistance from Enterprise PEI is non-repayable, although this will likely change.

Food Technology Centre (FTC)

The FTC was established in 1987 and is a division of Enterprise PEI. It provides technical services to government and private industries in the province in secondary processing and value-added activities for fish and agricultural products. The Centre is also engaged in research and development, technology transfer and integration, trouble-shooting in processing operations, production support and training of staff, and provision of technical assistance in the development of new processing operations.

For example, suppose an aquaculturist would like to produce a value-added product. He could contact Enterprise PEI and they could do market research on what products would be most acceptable to the consumer. This information could then be used by the producer to decide which product would be the most cost-effective and the FTC could then research and develop the process or recipe for this new product. Once the product is developed, Enterprise PEI could then do market tests to determine if it is acceptable to the consumer, in terms of taste, convenience, price, etc. If it is not acceptable, the product may be abandoned. If acceptable, the producer may then begin production of the new product. The work done by FTC is on a cost-recovery basis, although funding is available (up to 40-50% of cost).

The FTC has an international orientation, as staff travel extensively on international projects and the facility in Charlottetown offers short-term training courses to international clients.

Marketing and Product Development, PEI Development Agency

Assists in promotion of aquacultural products.

Prince Edward Island Department of the Environment

Ensures that aquaculture practices do not adversely affect the environment in the present or may result in problems in the future. For example, the Department of Environment tests the water returning to the ground after it has passed through a hatchery or culturing facility.

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V.1.3

AQUACULTURE ASSOCIATIONS

PEI Cultured Mussel Growers Association

P.O. Box 750

Kensington, PEI, C0B 1M0

PEI Shellfish Association

P.O. Box 8, Site #1

Bedeque, PEI, C0B 1C0

The PEI Association is an umbrella association for the Queens and Prince County associations. Primary interest of these associations is oyster and quahaug culture.

PEI Trout Growers Association

P.O. Box 2547

Charlottetown, PEI, C1A 8C2

V.1.4**BUSINESS/CONSULTING SECTOR Atlantic Fish Health, Inc. (AFHI)**

University of Prince Edward Island

550 University Avenue

Charlottetown, PEI, C1A 4P3

Tel: (902) 566-0545

Fax: (902) 628-4355

For more information, see section under Atlantic Veterinary College.

Atlantic Mussel Consultants

P.O. Box 1082

Montague, PEI, C0A 1R0

Tel: (902) 962-3378; (902) 651-2876; or (902) 962-3089

Consulting available for experience-based mussel culture as well as a marketing system design for seafood.

Atlantic Consulting Inc.

P.O. Box 75

Cardigan, PEI, C0A 1G0

Tel: (902) 583-2202

Provides consulting on experience-based mussel culture and mussel processing.

Atlantic Sea Smolt Ltd

R.R.#4

Souris, PEI, C0A 2B0

Tel: (902) 687-3334

Fax: (902) 687-3335

Atlantic Sea Smolt Ltd. provides smolt of Atlantic salmon, Arctic charr and rainbow trout in a certified disease-free hatchery. Salmon smolt are shipped to New Brunswick and salmon and trout eggs and fry are shipped throughout the Maritimes and to the United States. This is the only salmon hatchery in Prince Edward Island. This company has developed monosex broodstock to eliminate the problem of precocious males. A law requiring cultured Atlantic salmon in British Columbia be monosex populations may be finalized in approximately five years and such a trend may be observed in Atlantic Canada.

However, there are still many unanswered questions concerning monosex populations, including their performance, susceptibility to stress, disease, handling and movement, and poor water quality. The company is a world leader in the use of cryogenics for the storage of fish milt and wishes to pursue national and international agreements for further work on the cryogenic storage of milt. A major advantage for the use of cryogenetics is that there can be a 50% reduction in the population size which amounts to a considerable cost reduction.

Hidden Valley Charr Ltd.

Aquagenetics Corp.

R.R.#2

North Wiltshire, PEI, C0A 1Y0

Tel: (902) 658-2090

Fax: (902) 658-2090

These two companies focus on the advancement of aquaculture technology for Arctic charr eggs, fingerlings and meat fish. They are certified disease-free hatcheries for unique strains of Arctic charr and have developed a defined broodstock for Arctic charr. As well, these companies make use of the latest technology in recirculating systems in the large new state-of-the-art hatchery and growout facility in North Wiltshire, Prince Edward Island. Hidden Valley Charr is a wholly-owned subsidiary of Crystal Springs Aquaculture, a company from New Brunswick.

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Once completed, the facility in Prince Edward Island will be the largest producer of Arctic charr in Canada. The facility includes hatchery and growout facilities. Eggs are presently being shipped to West Virginia, and the fry to destinations in Canada. The market-size charr are sold head-on, gutted to various markets, Boston being the predominant destination.

Representatives in the company are enrolled in the NexPro course in their quest to open up their product to international markets. By 1997 the company hopes to be operating at full capacity. This will mean that they will be able to spawn the charr year-round, ensuring a consistent, high-quality product which will be available on the market at any time of the year.

To date, the main focus of their work has been on the production and export of the charr products, with the principal means of advertising their product being on-site visitations, trade show participation and word of mouth. However, there is great potential for the company to move into knowledge-based export. Their aquaculture technology can be applied to a variety of new species, in cold- and warm-water aquaculture. In conjunction with Hologenetics, research is being done on DNA fingerprinting, and the use of this technique and application of it to a hatchery/ growout operation is a viable export commodity.

DNA fingerprinting allows the genetic code of each fish to be determined, thereby ensuring that crosses are genetically distanced enough to prevent inbreeding. As well, parental crosses that produce young which show better growth and physical characteristics can be repeated to result in a better quality product.

In conjunction with AVC, software is being developed that will incorporate data-keeping for this DNA fingerprinting and associated genetic crosses, accounting for the company, and business/inventory management. It was stressed that more information is needed on the biological requirements of charr. Different strains of the fish have different requirements and these should be fine-tuned. As well, the company makes use of a computerized feeding system, which was developed in the U.S. for white sturgeon and modified for salmon.

Shur-Gain Division, Canada Packers Inc.

3 High St., P.O. Box 1630
Summerside, PEI, C1N 2V5
Tel: (902) 436-4811

Shur-Gain is now producing high-energy pelleted salmon and trout feeds which have fat levels of more than 25% and contain about 60% high quality fish meals. This feed can be broken down more efficiently by salmon and trout, resulting in improved digestion and better growth.

Waterline Ltd.

R.R.#2
North Wiltshire, PEI
COA 1Y0
Tel: (902) 658-2102 or (902) 368-3463
Fax: (902) 658-2102 or (902) 368-3463

This company manufactures a standard line of fibreglass- reinforced aquaculture production tanks and water treatment technologies. Its current market area is limited to North America. This is the predominant company in Canada for the design and equipment supply for custom-designed educational and research facilities and intensive tank-based finfish production systems. It has also developed intensive shellfish holding systems. This company has been contracted by several agencies for feasibility studies and for research and development of specialized aquaculture and holding technologies. Waterline Ltd. is presently seeking agents and distributors to market its technologies outside of North America.

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V.1.5

COMPUTERIZED SYSTEMS

Shellfish Management Program (SMP)

This program was developed over the last four years. Funding was provided by the Governments of Canada and Prince Edward Island through the Cooperation for Fisheries Development Program. AVC contributed the computer software, programming and facilities for the project.

SMP is a comprehensive, computerized on-farm management program for shellfish producers as well as an on-site harvesting management program for shellfish processors. The Program allows shellfish producers to:

- monitor "in-water" inventory;

- generate visual representations, through the use of graphs, of the major physical parameters specific to the site or sites of production; and
- monitor farm production and efficiency.
- the Program allows shellfish processors to monitor shipments received from, as well as payments to, the shellfish producers.

NOVA SCOTIA

V.2.1

AQUACULTURE EDUCATIONAL FACILITIES

Fisheries Training Program

The Aquaculture and Inland Fisheries Division of the Nova Scotia Department of Fisheries, in conjunction with Employment and Immigration Canada, offers a Fisheries Training Program. These are short courses offered in different parts of the province. Subjects studied include safety, equipment repair and business management. Weekend seminars are also held to upgrade skills in shellfish and finfish culture.

Fisheries Training School

The program is run in Pictou by the Nova Scotia Department of Fisheries and offers a two-year diploma course in shellfish and finfish culture and business administration.

Nova Scotia Agricultural College

This College, located in Truro, has begun a new, four-year professional program in aquaculture (first students were enrolled in September 1995 and graduate in May 1997). Areas of study include seafood processing, aquaculture business management, water quality control, finfish nutrition and feed industry service, pharmaceutical sales, aquaculture product management, equipment design and manufacturing, and shellfish and hatchery management.

Dalhousie University, Department of Biology

Facilities are offered for undergraduate, post-graduate and doctoral research, as well as occasional courses in aquaculture at the undergraduate and graduate levels.

Technical University of Nova Scotia

Facilities are provided for undergraduate and graduate research in aquaculture technology, as well as extension services.

University College of Cape Breton, Department of Biology

An aquaculture course is offered as part of its biology degree program.

Bras d'Or Institute, University College of Cape Breton

Practical assistance is offered to local aquaculturists and develops technical and biological research projects in response to growers' need and problems. Workshops are held occasionally.

St. Francis Xavier University, Department of Biology
Research and degree programs focus on aquatic biology.

V.2.2

TECHNICAL ASSISTANCE

Nova Scotia Department of Fisheries and Aquaculture
Field staff and aquaculture inspectors answer questions regarding sites and equipment, fish behaviour and health.

Department of Fisheries and Oceans, Fish Health Service Unit
Diagnostic service is provided for aquaculture facilities in the Maritimes, Quebec and western Newfoundland.

V.2.3

AQUACULTURE ASSOCIATIONS

quaculture Association of Nova Scotia

P.O. Box 802, Station M Halifax,

NS, B3J 3E4

This association is an active lobby and support group with a membership of approximately 200. It holds a three-day conference and general meeting each year and publishes a newsletter, entitled Aquanotes.

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V.2.4

BUSINESS/CONSULTING SECTORS

Acadian Seaplants Ltd. 30 Brown Ave. Dartmouth, NS, B3B 1X8 Tel: (902) 468-2840 Fax: (902) 468-3474

Acadian Seaplants Ltd. is the largest independent manufacturer of seaweed products in North America. It has developed expertise in a range of seaweed processing and manu-facturing technologies, and is a world leader in the development and cultivation of new customized hybrid strains of marine plants for chemical extraction and food markets. Its customers are in over 30 countries throughout the world.

Canadian Fishery Consultants Ltd. (CFCL) 1312 Queen Street Halifax, NS, B3J 2H5 Tel: (902) 422-4698 Fax: (902) 422-8147

CFCL is a consulting firm which offers services in Canada and internationally (over 65 countries worldwide). Its four areas of specialization are: aquaculture, fisheries, plants and processing, and

port development. Much of the work outside Canada has been in the developing countries of Africa, the Caribbean, Central and South America, the Pacific and South East Asia. Aquaculture feasibility studies conducted include (1) on-shore marine holding system for American lobster; (2) potential for land-based aquaculture for Arctic charr; (3) formulation of aquaculture feeds; and (4) possible development of rainbow trout fish farm in Ontario.

Hologene Genetic Technologies Ltd. P.O. Box 31 Site 20, R.R.#4 Armdale, NS, B3L 4J4 Tel: (902) 494-1398 Fax: (902) 494-6899

Hologene offers the commercial use of its genetic analytical services and expertise in fisheries and aquaculture management in domestic and international markets. It has developed a farm-based genetic program for steelhead trout aquaculture, which allows fish farms to undertake scientific animal breeding (progeny testing, selective breeding and documentation of bloodlines) without interfering with ordinary commercial activities. Other current activities also include creation of a base population for selective breeding programs for Arctic charr, ongoing selective breeding for scallop aquaculture, comparisons of genetic variability in contemporary and historical cod populations, and analysis of interspecific hybridization of Tilapia in the southeastern United States.

Institute for Marine Biosciences (IMB) 1411 Oxford Street Halifax, NS, B3H 3Z1 Tel: (902) 426-8332 Fax: (902) 426-9413

IMB conducts research in varied areas of marine chemistry and biology, operates and maintains aquaculture research facilities and transfers knowledge and expertise to other members of the aquaculture community. Emphasis is given to toxin-producing microalgae, the genes and enzymes of algae and microorganisms, and commercial products made from seaweed. It is the world's only source of certified shellfish toxin standards and reference materials, and identified domoic acid, a shellfish toxin which caused problems in the mussel industry in Prince Edward Island in 1987. IMB wants to pursue collaborations with national and international aquaculture interests on projects aimed at determining more cost-effective and efficient means of aquaculture, improved nutrition, therapeutants, diagnostics and the aquaculture of new species.

Marine Gene Probe Laboratory (MGPL) Biology Department, Life Sciences Centre Dalhousie University Halifax, NS, B3H 4J1 Tel: (902) 494-1398 Fax: (902) 494-3736

MGPL is a centre for development of genetic techniques, especially fingerprinting tools for commercially important fish and shellfish. It is also a training centre and has hosted researchers from Belgium, Greece, Singapore, Norway, the U.S., People's Republic of China and many areas of Canada. Its focus is on the application of recombinant DNA technology to resource management and conservation, which has the potential to be used routinely in large-scale population and aquaculture studies. Hologene Genetic Technologies Ltd. is a private, spin-off company from the lab and handles commercial contracts.

MDS Environmental Services Ltd. 5595 Fenwick Street Suite 200 Halifax, NS, B3H 4M2 Tel: (902) 420-0203 or 1 800 565-7227 Fax: (902) 420-8612

MDS Environmental Services are a wholly-owned subsidiary of MDS Health Group Ltd., Canada's largest health and life sciences company. The Halifax location serves as the Group's technology-based, marine toxin research organization. MDS, in collaboration with NRC,

identified, detected and quantified diarrhetic shellfish poisoning. MDS is presently developing a dock-side testing kit for paralytic shellfish poisoning (PSP) toxins.

MDS wishes to work with global organizations to further develop innovative technologies and to market them in North America and world-wide.

SFT Venture R.R.#1 Hubbards, NS, B0J 1T0 Tel: (902) 228-2579 Fax: (902) 228-2297
SFT Venture produces and markets shellfish such as European oysters, American oysters, scallops and mussels. Most of the final product is shipped to Europe and the United States, with some sales to Canada. As well, SFT acts as a broker for a wide range of seafood products, and operates a shellfish hatchery and has participated in major research programs relating to hatchery production. SFT also supplies much of the aquaculture equipment to the industry in Atlantic Canada. SFT wishes to promote its products in Britain, France, Spain and Belgium.

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NEW BRUNSWICK

V.3.1

AQUACULTURE EDUCATIONAL FACILITIES

New Brunswick Department of Fisheries and Aquaculture

This Department organizes a series of seminars and workshops for growers, which emphasize the basic skills needed to run an aquaculture operation. Topics have focused on fish disease, nutrition, genetics and biology, as well as daily operating and maintenance procedures, business planning and administration.

Huntsman Marine Sciences Centre (HMSC) -- Aquaculture Technician's Training Program

This program is offered by HMSC, through the New Brunswick Community College. It is a one-year course containing classroom and laboratory work with experience in commercial operations. HMSC cooperates with various government departments involved in funding native programs, including aquaculture-related work. HMSC, in conjunction with the University of New Brunswick (Fredericton) organizes graduate courses, and the HMSC offers a 12-week course at the New Brunswick Community College.

The following universities in New Brunswick offer undergraduate programs and graduate research:

Université de Moncton, Département de Biologie Moncton, NB, E1A 3E9

University of New Brunswick, Department of Biology Fredericton, NB, E3B E61

University of New Brunswick, Marine Research Group P.O. Box 5050 Saint John, NB, E2L 4L5

V.3.2

TECHNICAL ASSISTANCE

Department of Fisheries and Oceans In the Gulf Region, there are two

Shellfish Research Units:

343 Archibald St.
P.O. Box 5030
Moncton, NB,
E1C 9B6 and Miminegash PEI, C0B 1S0

In the Scotia-Fundy region, there is one Finfish and Shellfish Research Unit at **St. Andrew's Biological Station** St. Andrew's, NB, E0G 2X0

DFO labs in Blacks Harbour regularly monitor the New Brunswick coast for marine biotoxins such as domoic acid and those causing PSP. As well, there is a Salmonid Demonstration Farm on Lime Kiln Bay, near St. George, which was opened in 1986. This facility provides data and practical information which assists growers in developing business plans and improving the efficiency on their farms. Experiments on salmonid culture are also carried out, on such topics as fish nutrition, cage design and stocking densities.

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V.3.3

AQUACULTURE ASSOCIATIONS (Day, 1989)

- **N.B. Salmon Growers Association**
St. George, NB,
E0G 2Y0
- **L'association des producteurs d'huîtres de Shippegan**
C.P. 326,
Shippegan, NB,
E0B 2P0
- **L'association des pêcheurs d'huîtres de la Baie de Caraquet, inc.**
C.P. 578,
Caraquet, NB
E0B 1K0
- **L'association des producteurs d'huîtres de la Baie de Lameque**
C.P. 514,
Lameque, NB
E0B 1V0
- **La fédération ostréicole de la péninsule acadienne**
Boite 19, Site 8,
RR#2, Caraquet, NB
E0B 1K0

- **L'association mytilicole acadienne de la région d'est**
C.P. 835,
Caraquet, NB
E0B 1K0

V.3.4

BUSINESS/CONSULTING SECTORS

Corey Feed Mills

136 Hodgson Road
Fredericton, NB,
E3B 5W6

Tel: (506) 459-5588 or 1 800 561-0072

Fax: (506) 450-4817 Corey Feed Mills is a Maritime-owned and operated feed mill producing a full range of salmon and trout feeds, lobster feed, hatchery feed, and eel feed, all of which can be custom blended. Current markets are in North America, as well as the Czech Republic. The company wishes to do collaborative work with international clients in customized feed requirements and develop export markets in shrimp and other aquaculture feed products.

- Research and Productivity Council --
Food, Fisheries and Aquaculture Department (FFA)
921 College Hill Road
Fredericton, NB,
B3B 6Z9
Tel: (506) 452-1368
Fax: (506) 452-1395 The FFA is a corporate body of the Province of New Brunswick and provides technical assistance to the aquaculture industry in the areas of fish health protection and value-added processing. It has developed and uses a forensic technology through which illegally harvested wild Atlantic salmon can be distinguished from farmed salmon. As well, the company has had extensive experience in the international forum by providing technical assistance in fisheries, aquaculture and seafood product development through CIDA (Canadian International Development Agency) projects in the Caribbean Basin, South and Southeast Asia, and international client relationships are strongly encouraged. The arrangements are on a contract, fee-for-service basis. Patentable products and processes resulting from the work are assigned to the client on an outright ownership or royalty basis, depending on previously arranged circumstances.

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VI

KNOWLEDGE-BASED DEVELOPMENT

Davis and Botkin (1994) discuss knowledge-based development in their paper, entitled "The Coming of Knowledge-Based Business." The following information is extracted from that article.

The next wave of economic growth will see the economy shift from data to information to knowledge. "Data" are the basic building blocks of the information economy and a knowledge-based business. This data can be in the form of numbers, words, sounds and images.

"Information" is data that has been arranged into meaningful patterns. For example, numbers are data but a random number table is information. The application and productive use of information transforms it into knowledge.

Following are six elements of knowledge-based business, which provide guidelines on how a mature business can upgrade its offerings in a way that puts information to productive use:

- The more you use knowledge-based offerings, the smarter they get.
- The more you use knowledge-based offerings, the smarter you get.
- Knowledge-based products and services adjust to changing circumstances.
- Knowledge-based business can customize their offerings.
- Knowledge-based products and services have relatively short life cycles.
- Knowledge-based businesses enable custom-ers to act in real time. Knowledge-based products can also act in real time.

The article concludes by pointing out that it is business, more than government, that is instituting the changes in education required for the emerging knowledge-based economy, and that over the next few decades, the private sector will eclipse the public sector as our predominant educational institution.

The following information concerning knowledge-based development is extracted from an article by Knight (1993), entitled "Sustainable Development -- Sustainable Cities." According to the author, who stresses the need for cities to adapt to knowledge-based development, the focus toward such development is a result of several factors, such as:

- the advancement of science and technology;
- the changing nature of wealth creation;
- the specialization and the division of knowledge;
- the intensification of global economic forces;
- the increasing complexity of interpersonal and inter-institutional relations and the globalization of production; and
- a growing awareness that industrial growth with minimal regard for human and ecological values has reached its limits.

Knowledge-based development is not new. It has been present but has been overshadowed by other types of development which were quantitatively more important. Unlike labour-intensive production activities which tend to grow in spurts, rising and falling with product and business cycles, knowledge-intensive activities evolve incrementally and undramatically, whether they are

based in educational and research institutes or within industrial companies. However, even though they grow slowly, they grow steadily.

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VI.1

DEVELOPMENT POTENTIAL OF THE KNOWLEDGE BASE

1.1 *Exports of Knowledge* As knowledge-based activities develop, they must become increasingly internationally oriented since their development depends primarily on the ability to expand markets and export knowledge internationally. Exports are most important in industrial organizations but are becoming increasingly important in research and educational organizations, which tend to be oriented toward the home market.

There is great potential for development of export activity among educational and research organizations (Knight, 1993):

- Universities can become international institutions, increasing the role of foreign students and, subsequently, research funds from abroad can grow considerably.
- The export of knowledge by direct transfer, i.e., by educational and research organizations, helps the local economy by generating a flow of funds which accompany such transfers into it.
- As educational and research institutions advance their knowledge and upgrade their programs, they upgrade their function, causing a rise in income flows. This means that instead of teaching students, they teach the teachers. Instead of providing solutions to problems, they teach others how to solve their own problems. They continue to advance their knowledge by assimilating knowledge gained from new applications and specializing in the highest level and most difficult problems.
- Researchers and scholars can attend and use laboratory facilities for their experiments, thereby creating demand for knowledge-based activities, through personal, professional and alumni relations formed while visiting the city.
- Increasingly, knowledge is being exported in the form of direct transfer to professionals rather than being embodied in a product. Knowledge transfers and exchanges usually require the presence of professionals for extended periods of time, from a few weeks to a few years. Knowledge transfers are increasing, both in industrial organizations which are increasing their training budgets and building special training facilities for employees and clients, and in educational and research institutes which host professionals and scholars while they acquire or exchange knowledge. Most of Research and Development activities are conducted by research institutes which also sell their services on a contract basis.

VI.2

BENEFITS OF KNOWLEDGE-BASED DEVELOPMENT:

ACTUAL AND POTENTIAL

Benefits associated with knowledge-based development (Knight, 1993) include such direct benefits as levels of income and employment in the knowledge sector. There are also indirect benefits, which affect the social, cultural, political and intellectual life of the community. Other advantages include close proximity to knowledge resources, resulting in cooperation among knowledge-based organizations and social contacts between knowledge workers and local residents.

Benefits derived as export-generated funds are spent locally. These funds spent locally create additional economic activities which support jobs in "locally oriented" activities, such as housing, retail, entertainment, public services, educational, social and cultural services for local residents.

Funds entering through the export sector and spent locally thus create second, third, fourth and fifth cycles of activity before they flow out of the local economy in payment for imported goods and services. These outflows are offset by new funds entering through the export sector.

The technical term for the total (direct and indirect) effects which this recycling of export earnings has on the local economy is the "export-base income multiplier effect." The actual level of benefits derived locally from activity in the export sector depends on the level of export activities and on the export-base multipliers, i.e., on the earnings and residency of workers in the export sector and on the percentage of expenditures spent locally.

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VI.3

LOCAL IMPLICATIONS OF KNOWLEDGE-BASED DEVELOPMENT

Following are trends that can serve as a guide for evaluating local implications of the growth of the knowledge sector (Knight, 1993):

- Knowledge-based organizations are coming under increasing competitive pressures to advance their knowledge base by upgrading knowledge resources and expanding their markets.
- The role which national governments played in establishing new knowledge resources and in advancing knowledge by supporting basic research is declining and the role of the market is increasing. The advancement of knowledge is becoming increasingly market-pulled as opposed to science or technology-pushed.
- Knowledge-based organizations have to position themselves strategically. This means they have to focus their efforts on strengthening core competencies. Strategic planning, market research, product development and marketing activities are increasing in importance at the organizational level, usually resulting in the expansion of knowledge-based activities, of knowledge networks and of the knowledge sector.
- Knowledge-based organizations are giving more attention to innovation and to increasing synergy between existing departments and activities than to diversification as was the trend in the not-so-recent past.

- International cooperation or alliances are becoming essential for strengthening core competencies, maintaining competitive advantages and supporting centres of excellence.

Development of knowledge sectors is evidenced more in terms of qualitative improvements than in quantitative changes. Upgrading takes the form of increases in total turnover and in value-added per knowledge worker and in qualitative characteristics such as increases in the skills and income levels rather than in increases in the number of knowledge workers or of space requirements. As the knowledge workforce and work environments are upgraded, the ratio of support personnel to knowledge workers tends to decline but the ratio of jobs created indirectly in the local sector increases.

There are ten conditions conducive to knowledge-based development (Knight, 1993):

- Knowledge is defined, perceived and valued as a form of wealth by the community at large.
- The importance and contribution of knowledge workers is explicitly acknowledged.
- The nature and role of knowledge resources are understood by the general public.
- Knowledge resources are thought of in regional terms and regional linkages along similar and complementary resources are articulated.
- Priority is given to improving the knowledge infrastructure, integrating new types of knowledge into the local culture in order to create synergies, improve the milieu for innovation, entrepreneurial, creative activities and lower the threshold for acquiring new knowledge.
- All members of society have access to careers in knowledge-based activities.
- City strengthens and promotes its "core competencies" and "centres of excellence."
- There are incentives and mechanisms which favour investing in locally based knowledge resources and networks.
- Scenarios and prospective studies explicitly account for the increasing role of knowledge and immaterial factors.
- Civic leadership is consciously developed.

Creating conditions conducive to knowledge-based activities usually involves changing values, cultures, behaviours and overcoming some deeply ingrained fears about knowledge.

Knowledge, unless clearly defined as including all types of knowledge, including informal and local knowledge as well as formal and global knowledge, is likely to be viewed as a source of power and the idea of knowledge-based development is likely to be rejected as being an elitist concept.

The first steps in building a local knowledge infrastructure are to identify and classify knowledge resources in a region and to categorize them according to shared interests such as similar core competencies, research, recruitment, training, financing and marketing needs. This is necessary because actions must be specifically tailored to specialized activities.

These territorial clusters often include diverse actors and organizations, spanning different disciplines and industries and including specialized departments of universities, research

laboratories, sections of large industrial establishments, small- and medium-size firms, job-shops, professional and technical services, public agencies, associations, consulting bureaus, etc.

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VII

LEGAL SUPPORT

Aquaculturists, like many in the public, often feel that they are over-regulated and this interferes with their ability to conduct their business to its optimum potential. However, they become aware of the usefulness of a legal framework when they have problems over which they have no control, such as water pollution, introduction of disease, other waterway-user conflicts, etc. Pillay (1994) discusses the importance of a legal framework for the aquaculture industry and the following information stems from his book.

The stage of development of the aquaculture industry requires distinct legislative bases so that it can be properly managed and suitably encouraged, while protecting the broader public interest. Major components of a legal framework should include:

- clear property rights on farm sites and cultured stocks;
- rights to appropriate governmental support;
- protection of water quality;
- prevention of environmental degradation;
- spread of communicable diseases;
- product quality and sanitation; and
- reduction in administrative hurdles.

Presently, in many countries, aquaculture is regulated by measures under existing or proposed legislation relating to land reform, water use, environmental protection, natural resource conservation, water pollution control, animal health and disease, public health and sanitation, fish and game, import-export trade, etc. Often, the absence of legal support or conflicting regulations have impeded aquaculture development.

The variety of administrative controls placed on aquaculture include -- besides the usual business concerns -- public hearings and consultations, inspections, procurement of licenses, leases, permits, approvals relating to methods of aquaculture, use of water, location of rearing facilities in navigable waters, discharge of wastes, right to occupy coastal or foreshore areas, importation and transport of aquatic organisms, sale of products and even the type of establishment in which they are processed. As well, regulatory powers are shared among the federal government, provincial governments and local governments.

If there is to be a policy that favours an orderly development of the sector on a sustainable basis, an early adoption of specific, comprehensive and unified legislation should be compulsory. Such legislation should not wait until problems and conflicts arise.

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COMPREHENSIVE NATIONAL LEGISLATION

Such legislation is required to replace the present dependence on a variety of legal instruments that are incorrectly applied to aquaculture. The first step in formulating this legislation is compilation and review of existing national and provincial laws and regulations which apply or may apply to aquaculture. One such analysis of legal framework in aquaculture was undertaken by Wildsmith *et al.* (1982). In addition, they formulated a draft model legislation.

Wildsmith *et al.* (1982) defined aquaculture to mean "the culture or husbandry of aquatic flora or fauna, but not including the raising or breeding in tanks, pens or cages of aquatic flora or fauna (a) as aquarium species, (b) in laboratory experiments or (c) by individuals on their own property as food for their own use."

It was found that during this analysis the majority of statutes are oriented to regulating rather than facilitating aquaculture.

The next action should then be to formulate comprehensive legislation, the purpose of which should be to facilitate an orderly implementation of future aquaculture development and provide an appropriate legal base for the existing industry.

In order to ensure that the proposed legislation will conform to public policy, it should be based on a national plan for allocating land and water areas for all various development projects, consistent with national priorities, national features of the resources and their existing uses.

Pillay (1994) goes on to suggest that there should be a lead agency designated with the knowledge and responsibility to help aquaculturists meet the regulatory requirements. Such an agency could be charged with the responsibility for consulting all the other agencies concerned and obtaining their clearances in the shortest time possible.

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VIII

ROLES OF GOVERNMENT AGENCIES IN AQUACULTURE DEVELOPMENT

VIII.1

REGULATIONS AND INCENTIVES

The federal and provincial governments can, through memoranda of understanding or agreement and appropriate legislation when required, delegate administrative and operational functions to one another. These have been signed (NS: 1986; PEI: 1987; NF: 1988; NB: 1989) to direct orderly development of aquaculture and the establishment of "one-stop" licensing and leasing of commercial aquaculture ventures.

Under these memoranda, the provinces have responsibility for aquacultural promotion, training and development. In New Brunswick and Nova Scotia, aquaculture licencing and leasing are handled provincially, but on Prince Edward Island the federal-provincial memorandum of understanding provides for federal administration of these services.

DFO is still responsible for overall protection and conservation of the fishery, protection of fish habitats, control of export and transport of fish, maintenance of the National Registry of Fish Diseases, administration of the Fish Health Protection Regulations, and the certification of disease-free aquaculture units as they pertain to specific pathogens. DFO also supports research and development in fish disease, nutrition and diet formulation, genetics and stock selection and the biology of culturable species of finfish and shellfish.

Permits for freshwater aquaculture operations are usually issued through provincial aquaculture offices in conjunction with a successful application for an aquaculture lease.

VIII.2

FEDERAL AQUACULTURE DEVELOPMENT STRATEGY

This strategy, released in 1995, is the result of several years of consultations and deliberations on how to best build a federal policy framework in which the aquaculture industry can flourish. It has a two-fold purpose:

- to enable the aquaculture industry to expand and remain competitive; and
- to promote preliminary and pre-competitive new species development.

All the strategy initiatives are designed to promote sustainable development. "Sustainable development" refers to development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

The Strategy outlines the following critical success factors required for Canada's aqua-culture industry to reach its full potential:

- 1. Government Commitment to Aquaculture Development: Government initiatives are primarily directed toward supporting infra-structure (i.e., R & D, education and training, etc.) and toward creating a regulatory and policy framework conducive to industry development.
- Improved Industry -- Government Partnerships.

To remain internationally competitive, industry must address factors that will lead to lower production costs and enhanced marketing capabilities, including:

- competitively priced broodstock, seedstock, feed and equipment;
- high-quality, clean and productive growing sites;
- safe and effective therapeutants;

- technological leadership for improved husbandry, new species development, innovative products and enhanced productivity;
- effective farm and business management techniques;
- a skilled workforce;
-
- effective marketing mechanisms and market intelligence;
- investment and operating capital; and
- a role in shaping a more transparent and consistent policy, economic and regulatory environment.

The federal contribution in aquaculture development is divided into the following roles:

- 1. Research: Research programs will have two dimensions: (a) they will promote research that supports industry competitiveness and new species development; and (b) they will support the generation of information necessary for fulfilling governments' statutory responsibilities regarding health, safety and the environment.
- Technology Transfer.
- Training and Development.
- Regulatory Framework: The federal government will undertake a comprehensive review of all federal legislation and accompanying regulations to identify and remove, where appropriate, constraints to aquaculture development.
- Environmental Sustainability and Interaction.
- Resource Allocation and Access.
- Product Safety and Inspection.
- Market Intelligence and Services: Market information will allow the industry to adapt quickly to changes in domestic and international markets.
- Access to Financing: Government policies and regulations can greatly influence the relative attractiveness of the industry to investors and financiers. Aquaculture will be included among eligible activities for loans and other financial services offered by the Farm Credit Corporation. As well, foreign investment and strategic alliances will be encouraged through Canada's embassies and posts abroad through the Investment Inflow Program.
- Communications.
- Performance Measurement and Improvement.

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VIII.3

ADDITIONAL FEDERAL GOVERNMENT DEPARTMENTS AND THEIR ROLE

(Federal/Provincial Aquaculture Working Group, 1994)

Environment Canada is responsible for monitoring water quality and classification of shellfish harvesting areas.

Human Resources Development Canada works in partnership with the Canadian Aquaculture Industry Alliance to effectively develop human resources in the aquaculture industry.

Agriculture and Agrifoods Canada regulates aquaculture in three areas: (1) fish feed, (2) veterinary services and (3) pesticides.

Health and Welfare Canada licenses and monitors drugs for use in aquaculture.

Atlantic Canada Opportunities Agency (ACOA) is the main federal agency designated with the responsibility to oversee regional economic development. Concerning aquaculture, ACOA is responsible for marketing activities related to product development, testing and support for innovative technology development.

ACOA and provincial agencies often work together on projects. For example, ACOA, in conjunction with the four Atlantic provinces in a cooperative agreement, is hiring a consulting firm to examine the aquaculture industry in Atlantic Canada, and possible international export markets. Initially, the consultant's report will include:

- an inventory of companies dealing in aquaculture;
- target markets for aquaculture products and/or services; and
- optimal methods of entering those markets.

The aim is to export an entire aquaculture system to the targeted market so complementary products and services will be grouped together. The first stage of the contractor's report is anticipated to be completed by the end of June.

One positive move which should make life easier for aquaculturists is the development of the *PEI Trade Development Centre*, started January 1, 1996. This facility includes a team of personnel, resulting in "one-stop shopping" for required information. Representatives from Enterprise PEI, ACOA and Industry Canada are all in one office for ease and convenience.

Industry Canada's mandate is to foster Canadian business development, efficient markets and Canadian competitiveness by integrating factors such as research and development and consumer programs. It also provides strategic information and analysis to business, improves business access to government, reduces internal barriers to trade, and manages \$6 billion of federal science and technology funding.

Related to aquaculture, Industry Canada administers export development programs and the Aquaculture Technology Consortium.

National Research Council (NRC) supports aquaculture research through its Industrial Research Assistance Program (IRAP). IRAP assists small- and medium-sized enterprises to improve their internal capability and competence in technology development.

Transport Canada, via the Coast Guard, is responsible for ensuring that aquaculture does not impede navigation in coastal waters.

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IX

EXTERNAL AID

Pillay (1994) discusses the importance of external aid in world aquaculture production. During the period 1978-1984, assistance to aquaculture from different sources rose steadily to US \$368 million (14.3% of total assistance to the fisheries sector). The following gives the percentages from different sources:

International and Regional Development Bank Loans	51.5%
Asian Development Bank	23.9%
World Bank	22.7%

From 1986 to 1992, financing of assistance showed no definite trend but reached a maximum of about US \$237.7 million in 1991. External assistance accounted for a production valued at approximately US \$12,000 million in 1984. This had risen to a production value of US \$28,374 million in 1991.

The Asian Development Bank (ADB) has increasingly focused on aquaculture in its lending strategy since 1980 and had, in 1992, a total of fourteen aquaculture projects and five fisheries projects that included aquaculture components. Total lending of these projects was close to US \$342.6 million or over 36% of total lending for fisheries development. IX.1

ADVANTAGES OF EXTERNAL AID (Pillay, 1994)

The basic objective of recipient countries in seeking external assistance for aquaculture development depends on the state of the industry. The main purpose of technical assistance is considered to be the improvement and transfer of technologies and the building up of national institutions and capabilities in support of development in the private and public sectors. As well, there will be increased government attention and commitment at higher levels to their program. Other incentives are the acquisition of equipment and supplies not readily available locally, and opportunities for better contacts with institutions and persons of donor countries and personal exposure to developments abroad.

In general, it can be said that technical assistance projects in aquaculture have, in most countries, benefitted the recipient countries by reinforcing development activities and strengthening public and governmental awareness of the potential of the sector.

The donor countries benefit by the opening up of new avenues of employment, technicians acquire experience of tropical aquaculture, and have opportunities to apply theoretical knowledge to practical problems under field conditions, resulting in them becoming aquaculture managers, advisers, consultants and experts. IX.2

METHODS FOR MARKETING SERVICES INTERNATIONALLY

Trade Commissioners and locally engaged Commercial Officers in Canadian embassies and

consulates overseas, and International Trade Centres (ITCs) in Canada, can provide Canadian companies with valuable information and advice as to how to market their products or services abroad.

2.1 *Industry, Science and Technology Canada (ISTC)* ISTC's mandate is to increase economic prosperity by promoting productive investments in industrial development and renewal in all regions of Canada.

Business Opportunities Sourcing System (BOSS) Companies wishing to export, or who are presently exporting, their product and/or services internationally can register with BOSS. This computer system is a joint venture of Industry, Science and Technology Canada and External Affairs. Information about the company (e.g., size, product line, production capabilities, sales, etc.) are included and this information then becomes available at Canadian embassies and consulates worldwide. If a service is required, the embassy can be contacted and they can contact interested companies. The information is available to the public.

2.2 *External Affairs and International Trade Canada*

International Trade Centres (ITCs) External Affairs, International Trade Canada, and Industry, Science and Technology Canada have established International Trade Centres (ITCs). These are responsible for delivering trade development programs and services of federal government departments, which assist Canadian firms in their export sales effort. The following information on ITCs and additional information on exporting can be found in a publication produced by the United States Trade, Tourism and Investment Development Bureau and External Affairs and International Trade Canada (1992), entitled *Canadian Exporters' Handbook on Doing Business in the U.S. Food and Seafood Market*. Trade development services offered to Canadian companies by ITCs include the following:

- *WIN Exports Computerized Trade Information Network* If a company is already exporting their product/service, the information is down-loaded to External Affairs and the WIN (World Information Network) system. This system keeps track of what has been exported and its associated value, and is, therefore, only accessible to those in Foreign Affairs. Companies can access their own information as well. As well, there are directories based on BOSS and WIN information. The BOSS and WIN systems allow contractors or potential buyers in international markets to access required products/services available from Canadian sources. It is important, however, that companies interested in exporting internationally register their company. This can be done by contacting the local Industry Canada office.
- *Export Counselling* ITC offices are part of the international network of Trade Commissioners with access to current information on trade opportunities and market access conditions around the world.
- *Export Programs* Examples of such programs include: (1) Program for Export Market Development (PEMD); (2) New Exporters to Border States (NEBS); and (3) New Exporters to the U.S. South (NEXUS).
- *Export Education* ITCs arrange and sponsor a variety of seminars and workshops on the fundamentals of exporting, federal trade programs and export market opportunities.
- *Business Service Centres* These offer a wide range of trade-related publications.

- *Other Services* ITCs also provide access to services offered by the Export Development Corporation (export financing insurance), the Canadian International Development Agency (development-assistance contracts in developing countries) and other government agencies.

Canada points out, however, that information concerning the extent and value of knowledge-based services that have been exported internationally is lacking, and that in the future, services, such as consulting, will be included in their statistics. The following three federal government programs also offer assistance to Canadian exporters:

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2.3 Canadian Commercial Corporation (CCC)

The CCC serves as prime contractors in government-to-government sales transactions and identifies Canadian firms capable of filling requests by foreign governments and international agencies for individual products or services.

2.4 Export Development Corporation (EDC)

EDC provides a wide range of insurance and bank guarantee services to Canadian exporters.

2.5 Federal Business Development Bank (FBDB)

FBDB offers three principal services to Canada's business community: (1) financial services; (2) investment banking; and (3) management services, such as counselling, training and information.

2.6 New Exporters Training and Counselling Program

A new course, geared toward companies interested in exporting their product, has started in Prince Edward Island. It is called New Exporters Training and Counselling Program, or NexPro, and it provides a series of comprehensive training and counselling sessions that will give the exporting know-how to companies who want to enter international markets. It was developed and is delivered by the Business Development Bank of Canada. Courses and workshops cover subjects such as solving export-related problems, identifying main markets to target for a particular product, developing and implementing an exporting marketing plan, and knowing how to finance exports.

NexPro also offers one-on-one counselling sessions. An agent will visit the company for a two-hour consultation and do an assessment of export potential, help develop an international marketing plan, review the topics dealt with in the seminars and workshops, and provide practical advice, contacts and references.

2.7 Trade Shows

Another method of letting prospective markets know about available products and services from Atlantic Canada is by representation at trade shows. For example, the Canadian Institute of Biotechnology takes a copy of a Business Network which lists and describes companies in Atlantic Canada and their products/services, including those dealing with aquaculture, whenever a representative attends a trade show.

2.8 Internet

With the growing trends in computer technology, more and more companies are making use of the Internet in advertising their products and/or services. This allows the company to advertise to potential clients throughout the world for a minimum cost as well as to keep abreast of potential buyers and their needs.

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X

SUMMARY AND PROPOSALS

When one thinks about aquaculture, what usually comes to mind is the culturing of fish or shellfish which can then be sold to the public. Therefore, the aquaculturist produces a food product which is sold for a particular price, depending on several variables. This is the type of economy we are presently accustomed to. But the next type of economy now being adopted involves a shift toward knowledge-based development. Knight (1993) points out that knowledge-based development is not new. It has only been overshadowed by other types of development. The author points out that the focus is shifting toward knowledge-based systems as a result of the following factors:

- the advancement of science and technology;
- the changing nature of wealth creation;
- the specialization and the division of knowledge;
- the intensification of global economic forces;
- the increasing complexity of interpersonal and inter-institutional relations and the globalization of production; and
- a growing awareness that industrial growth with minimal regard for human and ecological values has reached its limit.

As pointed out, knowledge-based systems are not new, but do require a different focus or way of looking at knowledge.

It is necessary to look at what is required for aquaculture to become knowledge-based. It will require that the entire industry move in a new direction and toward a new way of thinking and approaching the industry. The move toward knowledge-based services means that it is no longer sufficient to grow a mussel and sell that product to the market. All products have information inherent in them, e.g., how is the product produced? For the information embedded in a product

to become knowledge, there must be some application for and productive usage of that information. The consumer must be able to put a value on it.

Technology can be defined as "knowledge or techniques which produce goods and services used to expand society's knowledge of science" (O'Rourke, *personal comment*). Therefore, technology can be considered to be knowledge-based, although it is not technology alone that is important. Good tools should not be confused with the knowledge itself (Gary Stairs, *personal comment*).

Prince Edward Island is beginning to develop knowledge-based services, although still at a low level. Ten years ago, the Island was considered to have very few sources of technology. PEI is getting better, though, at using modern tools and making more modern tools to produce things that are needed. However, industry is still limited in its ability to discover alternative.

What is meant by these "tools?" Tools are the means of acquiring information. Examples might include microscopes, computerized systems such as the Internet, plankton nets, water quality testing apparatus. All these help to gain information on aquaculture. However, in order for this information to become knowledge, it must be used interactively with the consumer and producer. The application and productive use of the information transforms it into knowledge (Davis & Botkin, 1994).

It is for that reason that aquaculture must move toward a greater interaction between the customer and producer. It is not enough to produce a product and then find markets for that product. Producers must find available markets and then determine, on a one-to-one basis, what the consumer requires and change their production information to suit their customer requirements.

As pointed out by Davis and Botkin (1994), knowledge-based services and products must adjust to changing circumstances. These changing circumstances can only be known if there is interaction between the producer and customer so that the producer is able to provide a product or service that exactly meets the consumer's specifications. This should be encouraged and promoted if it can be done in a sustainable fashion.

For example, the smaller "cocktail" oysters, which are 37-76 mm in length, are more popular in the marketplace. However, the legal minimum size for the American oyster is 76 mm. Governments should be more receptive to the needs of the industry and be able to take steps to remedy such legislation more quickly. Following are additional examples of how such production based on requirements for individual customers are demonstrated:

- Specific companies may require smaller mussels for use in breaded mussel products or maybe larger mussels for chowder preparation.
- A company buying charr fry may want to purchase the offspring from a particular parental cross that previously had resulted in desirable characteristics in the marketplace.
- A customer may require information as to how to solve a disease problem that has been plaguing production levels. It is not only enough to determine what the disease is but also to provide the customer with the information as to how to treat it and follow through until the problem is solved.

These are just a few examples of how producers can value-add to their products or services they provide.

The following is another example of how a company can move into knowledge-based services: Moore-Clark, a company in British Columbia which provides feed to aquaculture endeavours, also supplies veterinary services for those companies which buy its feed.

Knowledge-based services also provide the user with the information needed to solve their problem. It is, therefore, necessary that this information be kept as current as possible. This is the problem with many government documents or hardcopy reports -- by the time they are printed, the information is already out-of-date.

One tool which combats this problem is the Internet. It provides information on what is going on in aquaculture throughout the world at any one time. As well, it can provide information as to what services are available or required throughout the world. However, the information available must be kept up to date. This should be delegated as a responsibility of a particular agency, such as an aquaculture association.

Aquaculture-related computer systems are valuable potential knowledge-based products. Such a program is the Shellfish Management Program, developed at the AVC with funding by the Cooperation for Fisheries Development Program. This program could be marketed to shellfish producers and processors throughout the world.

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According to Knight (1993), it is important that knowledge-based activities cooperate with each other as opposed to diversifying, which has been the trend. In addition to keeping such information up to date on the Internet, such an aquaculture agency should be responsible for maintaining a directory of aquaculture-related services which are available, and actively promoting these services via the Internet, trade papers, workshops, conferences, etc.

The project being done by ACOA, in conjunction with the four Atlantic provinces, is an excellent first step in this direction. In preparing an inventory of aquaculture services available and marketing entire aquacultural systems, the buyer is offered the complete spectrum of what is required for the particular aquaculture project. This could include personnel required to do feasibility studies on appropriate species to be cultured, providing necessary equipment, training for use of equipment and culturing methods, disease control, and marketing of final product.

This not only results in a well-rounded group of professionals setting up the most appropriate aquaculture system for the particular buyer but also in ensuring that the required services/technology originate in Atlantic Canada. This type of system, involving complete aquaculture projects or endeavours, could then be marketed more easily since it would save prospective buyers needing to hire a different company for each facet of the set-up, with the increased possibility of each having their own idea of what should be done.

Such a system should make use of aquaculture endeavours throughout Atlantic Canada. This would be more resourceful and would, one would hope, save the energy of competing with each other over the same market. Different niches could be developed. This is more in line with the cooperative reasoning behind knowledge-based services.

Another potential development is that of companies or countries forming a partnership which would mutually aid each other in terms of expertise. For example, one company may have lots of product but no marketing expertise, whereas another may have marketing expertise but not enough product. These two countries could combine their resources for their mutual benefit.

As well, this aquaculture agency should be responsible for acting as a go-between for companies wishing to move into the international market. The coordinator could take a course such as that offered by NexPro, in order to learn how to break into the international markets in general, and then concentrate on the aquaculture sector, particularly that of knowledge-based services.

Wildsmith *et al.* (1982), in analyzing the aquaculture-related legislation in Canada, found that the majority of statutes are oriented to regulating rather than facilitating aquaculture. Pillay (1994) stresses that comprehensive legislation should be formulated which will encourage and assist future aquaculture development and provide an appropriate legal base. As well, there should be a lead agency which could be charged with the responsibility of helping aquaculturists meet required regulations.

This could be the role of the agency previously described, that of liaison between aquaculturists and government departments. As it stands, producers sometimes feel that there is too much red tape in attempting a project. Government departments often do not know themselves what their exact responsibilities are and this proves to be very frustrating for the aquaculturist. As well, producers at times find it difficult to get their questions answered. These questions can take on many forms, such as applying for leases, problems in production, available grants or funding, etc. The aquaculture agency could assist the aquaculturist in getting such questions answered.

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X.1

EDUCATIONAL FACILITIES

There should be more emphasis placed on the educational aspect of aquaculture. Facilities are available for training in fish health at the AVC, for practical aquaculture training at Holland College, as well as short courses in fish health offered through the CAI.

All these courses should be combined and marketed as a degree or diploma course in aquaculture with a greater emphasis placed on international students and exchanges.

This recommendation was also put forward in the report, "Aquaculture Research and Training Organizational Study: Prince Edward Island." The consultants who did the study deemed that such an organization would have the potential to access contracts and students through

development aid and loan projects supported by major donors. Such an organization would require collaboration among the public sector, academic and private sector to offer research and training services to markets in Prince Edward Island, Canada and internationally.

Such an endeavour would aid Prince Edward Island by bringing foreign capital into the economy, as well as setting up contacts for future aquaculture projects. The facility could also serve as an international conference centre for aquaculture. In general, such a facility could be considered to be an Aquacultural Centre of Excellence.

Knight (1993) stresses that international cooperation and alliances are essential in knowledge-based services as they strengthen core competencies, maintain competitive advantages and support centres of excellence.

Such a move into the export of knowledge-based services will diversify the aquaculture industry, making it less susceptible to extraneous factors such as trade balance, currency exchange values, political and economic relations, etc. (Pillay, 1994). X.2

RISKS AND INSURANCE

Another factor which must be addressed is that of insurance. As it stands now, premiums are too high to make it feasible for many aquaculturists to purchase insurance. As well, when applying for bank loans or looking for investors, aquaculturists are often thought to be entering into a high-risk venture.

Pillay (1994) suggests that the risks experienced in aquaculture can be broadly classified as those that are caused by the state of technology, technical and managerial skills of operators, and uncertain financial support that is presently available to the sector. The risks associated with aquaculture were ranked as follows:

- occurrence of diseases;
- losses caused by natural disasters like floods, drought and storms, as well as the effects of red tides and algal blooms;
- losses due to poaching and theft, which increase with expansion of farming of high-valued species and cage farming;
- losses due to mechanical failure of the plant or equipment, which depends on the nature of the rearing facilities and the extent of mechanization (most important are mechanical failures of water delivery and drainage, aeration or oxygen supply); and
- public liability.

Pillay (1994) points out that a general review of experience so far does not appear to provide any convincing proof that aquaculture is intrinsically much more risky than other similar activities. By encouraging reasonable insurance rates and bank loans, the message would be sent out that aquaculture is a feasible industry which, in turn, would attract more investors.

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XI

CONCLUSION

There are opportunities which are presently being utilized or which could be explored for Prince Edward Island, and the Maritimes in general, in the export of aquaculture-related knowledge-based services. In addition to the educational facilities previously mentioned, Prince Edward Island has several aquaculturists who have the information required to develop aquaculture ventures. For example, Sefton Dixon of Atlantic Sea Smolt Inc. has a wealth of practical information concerning methods in setting up and maintaining a salmon hatchery. As well, the mussel growers on Prince Edward Island make use of innovative methods of shellfish culture especially geared toward northern climates. Winter harvesting techniques are just one example.

Other knowledge-based services available from the industry sector include various elements of fish health, such as disease prevention, diagnosis and treatment. Such knowledge is presently being sold by Atlantic Fish Health Inc. and the Canadian Aquaculture Institute. Food production technology is another source of knowledge-based services. Knowledge concerning aquaculture is available in the fields of marketing, environmental concerns and issues, enhancement of stock by genetic determination -- as is presently being explored by Hidden Valley Charr and Aquagenetics. Water control and management, as with the use of recirculating systems, is being supplied by Waterline Ltd. The Food Technology Centre and Enterprise PEI have knowledge on value-added products and appropriate marketing schemes. These are a few examples of areas where knowledge-based services in aquaculture can be exported.

This type of knowledge is available but it is necessary to change attitudes or the way of looking at this inherent knowledge acquired through the culturing of a particular species. This knowledge must be viewed as a commodity with a worth or value. As well, there must be some direction as to how this knowledge can be marketed and which markets should be targeted.

This paper just touches the surface of opportunities available in this shift toward a knowledge-based economy. Prince Edward Island has begun to move in this direction, and New Brunswick even more so in the general area of a knowledge-based economy. As this shift continues, more opportunities will open up Prince Edward Island, and the Maritimes in general, providing direction and complementary initiatives to such export.

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