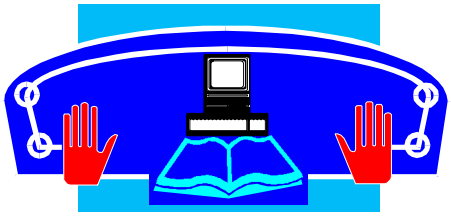

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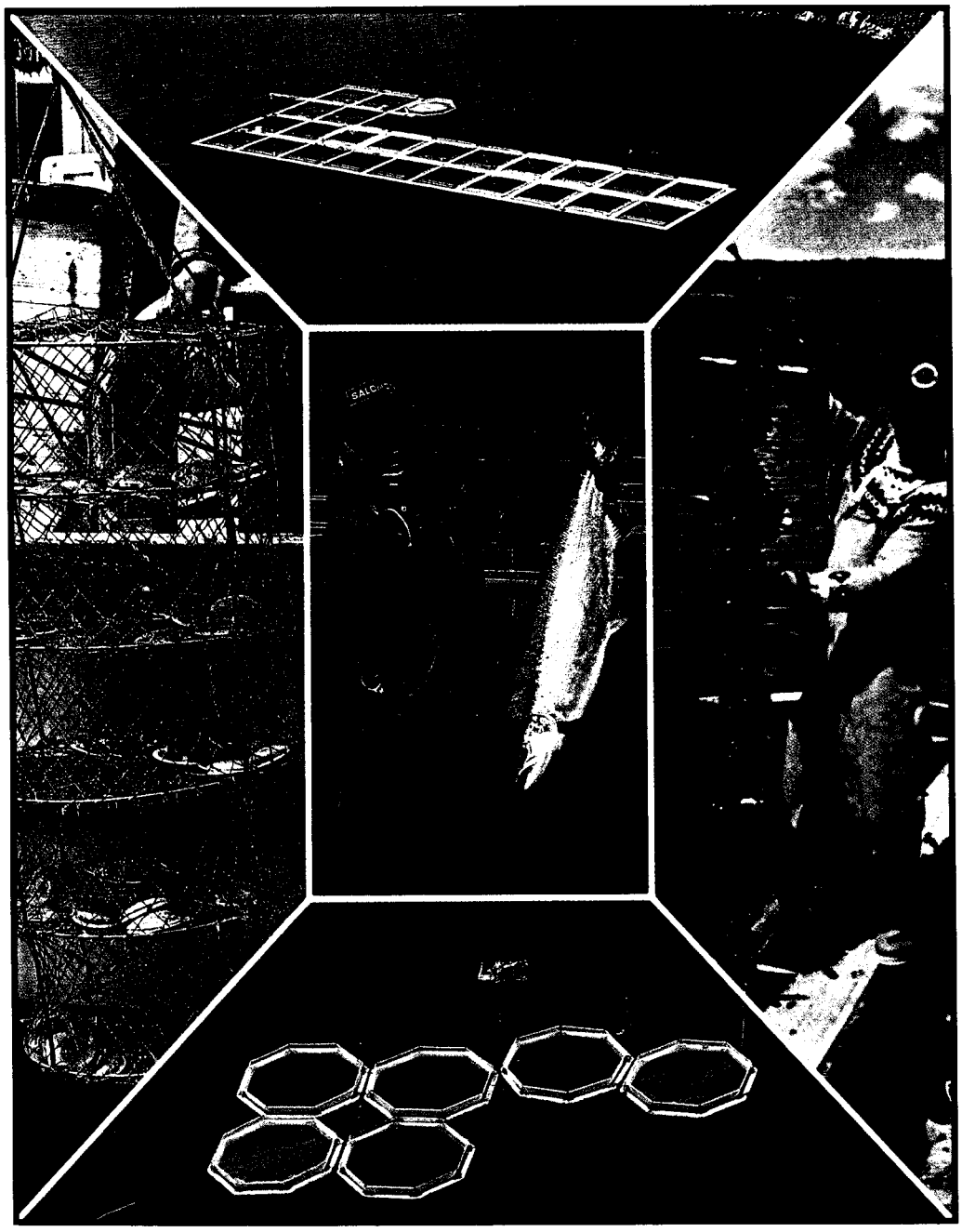
AQUACULTURE IN CANADA



Report of the **Standing Committee**
on **Fisheries** and Oceans

Gérald Comeau, M.P.
Chairman

AQUACULTURE IN CANADA

Report of the Standing Committee on
Fisheries and Oceans

Gerald Comeau, M.P.
Chairman

July 1988

HOUSE OF COMMONS

Issue No. 40

Tuesday, June 7, 1988
Tuesday, June 14, 1988
Thursday, June 16, 1988
Tuesday, June 21, 1988

Chairman: **Gérald Comeau, M.P.**

CHAMBRE DES COMMUNES

Fascicule n" 40

Le **mardi** 7 **juin** 1988
Le mardi 14 **juin** 1988
Le jeudi 16 juin 1988
Le mardi 21 **juin** 1988

Président: Gerald **Comeau, député**

Minutes of Proceedings and Evidence of the Standing Committee on

Fisheries and Oceans

Procès-verbaux et témoignages du Comité permanent des

Pêches et des Océans

RESPECTING:

Pursuant to Standing Order 96(2), an examination of the Aquiculture **Industry in** Canada

INCLUDING:

The Fourth Report to the House

Aquiculture **in** Canada

CONCERNANT:

Conformément à 1'article 96(2) du **Règlement, un** examen de **l'industrie** de **l'aquiculture** au Canada

Y COMPRIS:

Le **quatrième** rapport **à** la **Chambre**

L'Aquiculture au Canada

Second Session of the Thirty-third Parliament, 1986-87-88

Deuxième session de la **trente-troisième législature,** 1986-1987-1988

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St-John's East (NFLD)

The Standing Committee on Fisheries and Oceans has the honour to present its:

FOURTH REPORT

In accordance with its permanent mandate under Standing Order 96(2), your Committee has agreed to study the aquiculture industry in Canada and reports its findings and recommendations.

Pursuant to Standing Order 99(2) of the House of Commons, your Committee request the Government to table a comprehensive response to this Report.

ACKNOWLEDGEMENTS

The Committee acknowledges, with gratitude, the cooperation and support of all those who contributed to our study of Canada's Aquiculture Industry. We extend our thanks to all of the witnesses who appeared and shared with us their knowledge and insight on this subject.

We also extend our thanks to all fish farmers who welcomed members of the Committee on their farms and provided them with generous details on the daily operation of their business. Much appreciation is extended to all industry representatives and officials from the Department of Fisheries and Oceans for their contribution in putting together a well-balanced program for the conduct of this study.

We acknowledge the assistance of Pierre Touchette from the Research Branch of the Library of Parliament, and the expert advice provided by Dr. Robert H. Cook from the Department of Fisheries and Oceans.

The Committee expresses its appreciation for the logistics and administrative support provided by Jacques Lahaie, Clerk of the Committee.

The Committee wishes also to acknowledge the valuable cooperation of the staff of the Committees and Private Legislation Directorate, the Translation Bureau of the Secretary of State, and the support services of the House of Commons and the Research Branch of the Library of Parliament.

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FOREWORD

As part of its study, your Committee travelled to Norway and Scotland to study advances made by those countries in aquiculture. Your Committee also visited aquiculture facilities across Canada where a number of expert witnesses, industry participants and government officials presented their views. Your Committee is pleased to present its findings on aquiculture in this country, particularly saltwater marine aquiculture.

Aquiculture, especially salmon farming, is making substantial advances in Norway and Scotland. The climatic and geographical conditions of these countries are similar to those prevailing on Canada's western coast and in some areas of its eastern seaboard although climatic conditions there are generally harsher. Canada is blessed with extensive marine habitat on both coasts, yet the development of Canadian aquiculture has been slow. This is of some concern to the Committee. Through this report the Committee seeks to make Canadians aware of the opportunities offered by this industry, to facilitate its further development and to outline the precautions necessary for the protection of the environment, the wild fisheries and the interests of other resource user groups. While salmon growing will necessarily be the leading edge of this industry, the outlook is also positive for the cultivation of other species, particularly molluscs, such as oysters, mussels and scallops, as well as of marine finfish, such as halibut and sablefish.

1NTRODUCTION

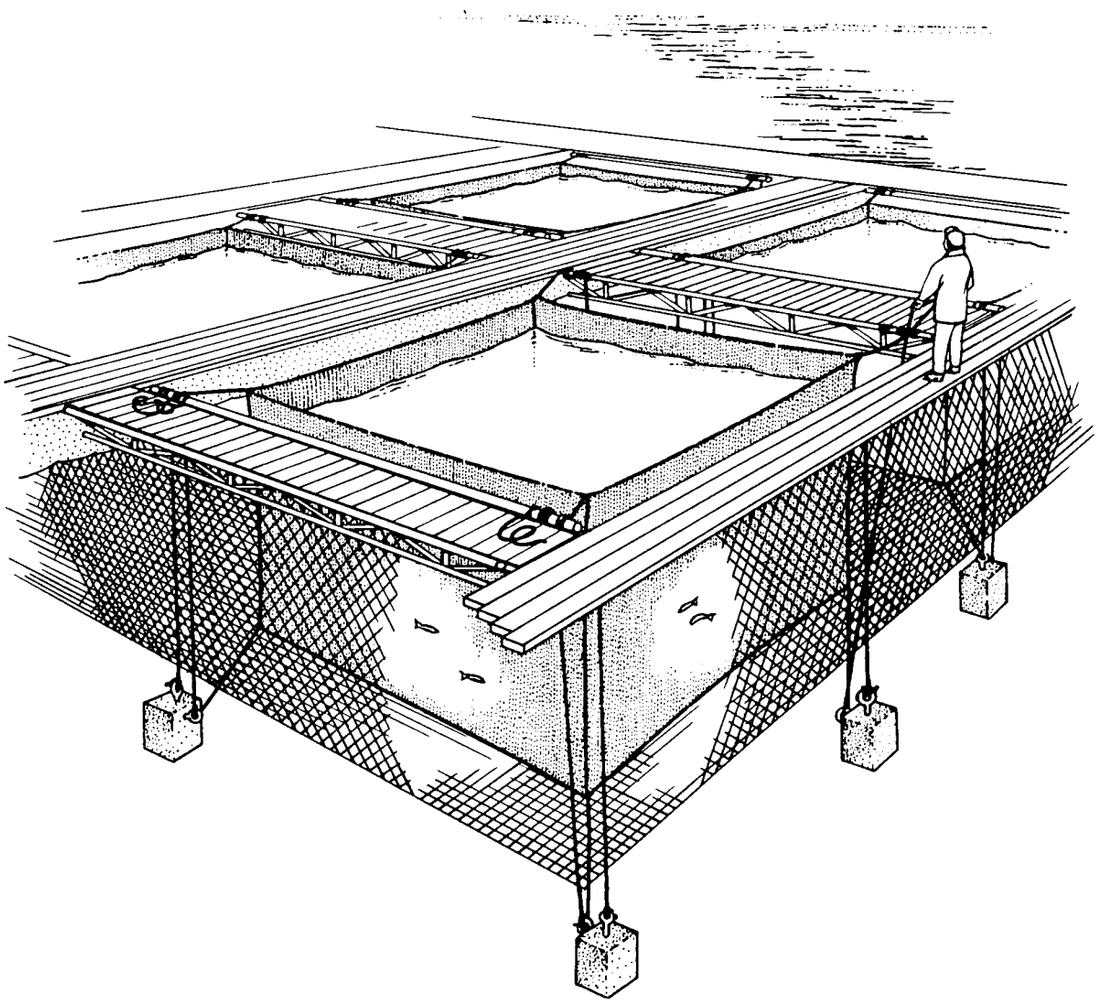
Aquiculture can be defined as the cultivation of aquatic organisms using artificial reproduction methods and husbandry techniques. The main forms of aquiculture dealt with in this report are finfish and mollusc aquiculture. In finfish aquiculture, juvenile fish are reared from eggs in hatcheries and grown to maturity in land-based tanks or net-cages immersed in water. Mollusc aquiculture includes the production of oysters and mussels by suspending seedstock in the water column from longlines or setting it on underwater leases. (illustrations of these aquiculture techniques are provided on the following pages) The many other forms of aquiculture include the production of marine plants and lobster holding techniques, both of which are carried out in Canada. It is not the intention of this report to review every type of aquiculture activity carried out in Canada or abroad; it is rather to present an overview of the current status of the Canadian industry and provide guidance for its future development including its extension to other species.

The Committee on Fisheries and Oceans supports aquaculture development in Canada because of the significant benefits this growing industry can provide. It can contribute to the economic development of rural areas, to the creation of jobs and wealth through Canadian and foreign investment, to R&D activities and spin-offs in related service and export industries not the least of which is the traditional fishing industry.

To obtain these benefits, however, aquiculture has a number requirements, such as private sector financing, public sector support and the infrastructure development. Also required is the elimination of a number of constraints such as lack of clearly defined federal and provincial responsibilities and conflict between the aquiculture industry and other resource user groups.

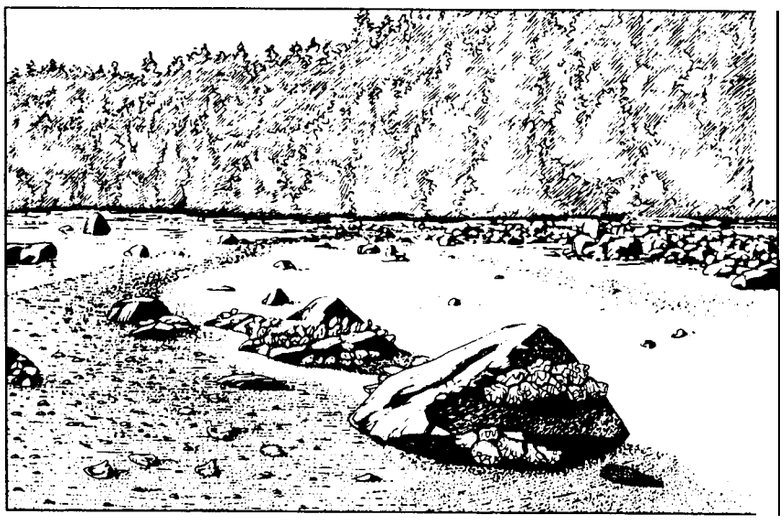
This Report highlights the opportunities and problems, constraints and requirements of Canadian aquiculture development. Its major objective is to bring forth recommendations to facilitate the rational development of the Canadian aquiculture industry in context of the total Canadian fish production system.

SALMON FARM FLOAT AND NETPEN

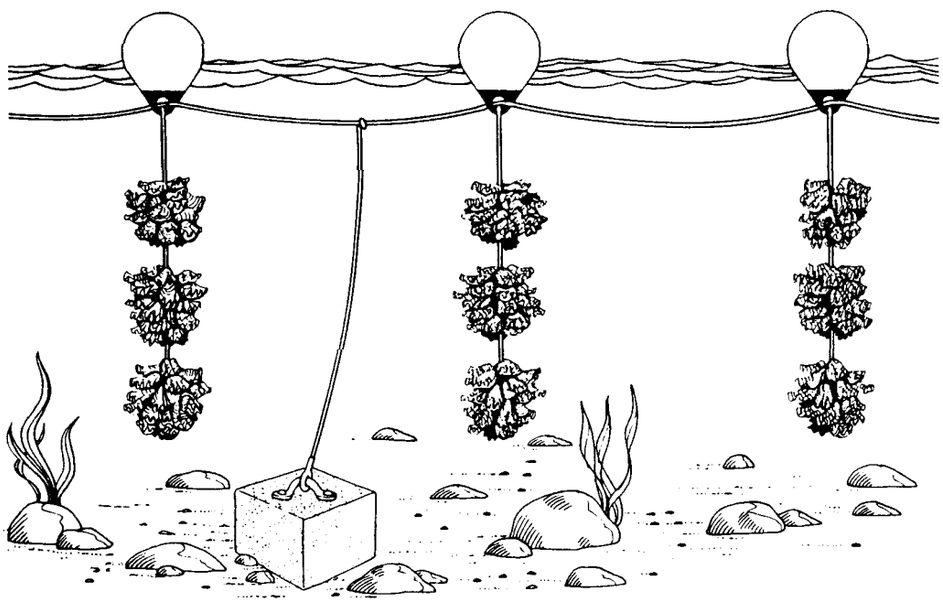


Source: *Aquaculture in BC: Getting Started*, Province of British Columbia, Ministry of Agriculture and Fisheries; May 1986.

BOTTOM OR BEACH
OYSTER CULTURE



LONG LINE OYSTER CULTURE



Source: ***Aquiculture*** *in BC: Getting Started*, Province of British Columbia, Ministry of Agriculture and Fisheries; May 1986.

BACKGROUND

This section of the report summarizes those findings of the Committee's trip to Norway and Scotland which are relevant to the Canadian situation. More detailed information on the aquiculture industries of these two countries is provided in Appendix "B" which contains the Committee's third report.

A. Norway

At present, the Norwegian aquiculture industry is almost exclusively based on Atlantic salmon aquiculture although much research is being carried out into the possibility of intensive fish farming of other valuable species such as halibut and turbot; it is expected that by the mid- 1990s halibut aquiculture will be fully on stream. The indications are that government sponsored aquiculture research and development in Norway is increasing.

Norway initially favoured the development of small owner-operated and locally-based aquiculture businesses consistent with the regional development objectives of the Norwegian Parliament. Publicly funded programs offering grants and loan guarantees encouraged the establishment of fish farms in specially designated, mainly rural, areas in the northern parts of the country. Such policy measures helped to increase the amount of risk capital available for the industry's development.

Although regulations designed to maintain small owner-operated enterprises have recently been relaxed, pressure continues from farmers, for an increase in the maximum size of marine cages as a way of maintaining an economic competitive edge. Competition on the Norwegian aquiculture industry's closest markets (such as the EEC) is increasing, often under the impetus of the Norwegians themselves, who have invested in other countries where size and ownership restrictions are much less stringent. Investment abroad. and the resulting increase in international competition, is accepted by the Norwegian authorities for two reasons: one is that the markets are thought to be sufficiently large to accommodate increases in production resulting from the aquiculture development in such countries as Canada and Scotland (the United States market especially is thought to offer tremendous product export opportunities); the other reason is that aquiculture abroad expands technological and equipment markets for the Norwegian aquiculture service industries.

In spite of its evident successes, the Norwegian aquiculture industry is struggling with some serious problems. The level of scientific knowledge of fish health, husbandry and the effects of the industry on the environment lags behind the industry's level of development. There is insufficient research into fish health and a lack of veterinarians who are specialized in this subject. This is particularly evident in the lack of fish health services in outlying areas, where most of the fish farms are located. It is thought that many of the disease problems currently faced by the industry are related to environmental pollution and the husbandry practices at fish farms. The authorities are considering implementing regulations for the operation of fish farms. These would include strengthening site pollution controls and establishing standards for the professional competence of fish farm operators.

In Norway, the development of salmonid aquiculture did not give rise to conflicts between fish farmers and traditional fishermen. Unlike what is the situation in Canada, the Norwegian commercial salmon fishery was very small and served mainly the domestic market while the developing salmon aquiculture industry essentially serviced the export market. Moreover, many owners and workers in the Norwegian salmon aquiculture industry had been involved in the commercial herring industry, which had collapsed. In the industry's initial phases, the migration of workers from one industry to the other was facilitated by subsidies and grants. Employment in the Norwegian aquiculture industry is estimated to be around 4,000 jobs with an additional 4,000 jobs in related services.

The production potential of the Norwegian salmon aquaculture industry is estimated to be around 100,000 tonnes. However, the industry is not expected to achieve this potential until infrastructural problems are resolved. In 1987, salmon production had been expected to reach 53,000 tonnes; however, disease problem led a down-sizing of this estimate to 47,000 tonnes valued at nearly $440 million. Production was forecasted to reach 80,000 tonnes starting in 1988; however, this is now doubtful, due to current industry problems.

B. Scotland

As in Norway, aquiculture in Scotland is predominantly directed towards raising Atlantic salmon, since the market opportunities for that species are better than those for trout. Scotland is apparently more advanced than Norway in raising molluscan shellfish species such as mussels and is

also carrying out research into the possibilities of farming other species, such as turbot and halibut.

The development of the Scottish aquiculture industry has been totally different from that of Norway. In Scotland there are no regulations on the size and ownership of aquiculture facilities. As a result, the Scottish aquiculture industry was essentially pioneered by large corporations which had the financial resources to develop the technology. Subsequently, once initial capitalization costs decreased, many small producers entered the industry with the help of the publicly funded regional development programs of the Highlands and Islands Development Board. As a result, the Scottish industry has grown tremendously in the past four years. For example, the direct employment provided by this industry is currently estimated at around 1,200 jobs. It is expected that within a few years, the Scottish industry will be producing the same numbers of pen-raised Atlantic salmon as the Norwegian industry. Scottish salmon production is currently at a level of 15,000 tonnes. It is expected to reach 45,000 tonnes in 1989 and possibly 63,000 tonnes by 1990. In addition to being faced with a learning curve less steep than that faced by the Norwegians, who pioneered the industry, the marketing prospects of Scottish salmon aquiculture are enhanced by the current difficulties of the Norwegian industry. The United Kingdom, as a member of the EEC, has a freer and more assured access to this market than Norway.

Like the Norwegian salmon aquiculture industry, Scottish aquiculture has a number of problems to contend with. One of these is the lag between infrastructural development, knowledge in fish health and husbandry sciences and the industry's growth. Another is the lack of regulations relating to planning controls, especially over the siting of marine aquiculture operations; for example, there are no regulations specifying minimum distances between farms. This has a potential impact on fish health and the environment which raises concerns among various interest groups as to how the aquiculture industry is developing. The major factor which triggers opposition to aquiculture development is the density of farms. In addition, the unequal application of fish health regulations across the United Kingdom has apparently resulted in the spread of fish diseases from one area to the other.

Another problem in the Scottish industry relates to the marketing difficulties experienced by small producers. This is totally different from the situation in Norway, where aquiculture products are marketed by a central

sales organization with monopoly rights. The Scottish Salmon Growers Association is attempting to regroup small producers so that they can cooperate in supplying larger customers on a continuing basis.

As in Norway, aquiculture development in Scotland does not appear to have led to conflicts between the traditional fishing and aquiculture industries. There are two reasons: one is that aquiculture has developed in areas not linked to the commercial fisheries; the other is that, by North American standards, the commercial salmon fishery is practically non-existent.

ANALYSIS

This section of the report analyzes the current status of Canadian aquiculture, including jurisdictional agreements, regulatory framework, production statistics, and research and development requirements. It identifies the benefits that can be derived from aquiculture in Canada, as well as the requirements for and the constraints to its development.

A. Overview of Aquiculture in Canada

Since 1967, world aquiculture production has increased ten-fold from 1 million tonnes to 10 million tonnes in 1984. From annual average growth rates of nearly 40 percent in the late 1960's, world aquiculture production increases are now in the order of 6 percent annually. Aquiculture experts have predicted that world aquiculture production could reach 15 million tonnes by the year 2000 based on an annual average growth rate of 2 to 3 percent. However, given the increasing interest in aquiculture worldwide, this is a conservative forecast. Worldwide aquiculture production could reach the level of 15 million tonnes much earlier that the year 2000 if the growth rates experienced since the early 1980's continue uninterrupted. In 1984, world aquiculture production represented just under 10 percent of total world fish production. The comparative figure for Canada is about 1 percent.

The growth of Canadian aquiculture, unlike that in other parts of the world, has been slow and irregular. For example, in 1975, total aquiculture production was reported at around 5,000 tonnes for all species. This was at the time substantially higher than production in Norway. By 1980, however, when Norwegian Atlantic salmon production reached just under 10,000 tonnes, Canadian aquiculture production had dipped to around 4,000. This decrease is explained by a declining production of freshwater trout and oysters, which then constituted the bulk of Canadian aquiculture production. In addition, the extension of the Exclusive Economic Zone to the 200 mile limit led to substantial investment in the traditional fisheries at the expense of aquiculture development. Over the past three years or so, however, there has been a renewed interest in aquiculture and its extension to other species such as salmon and mussels has resulted in Canadian production reaching an estimated 11,000 tonnes valued at over $32 million in 1986, as shown in the following table.

Aquiculture Production in Canada in 1986

	Quantities (tonnes)	Value ($000)
Pacific salmon	397	2,702
Atlantic salmon	307	3,724
Trout	2,384	16,193
Pacific oyster	3,700	3,000
American oyster	2,400	3,704
European oyster	5	60
Blue mussel	1,485	2,849
clams	7	14

Source: Department of Fisheries and Oceans.

According to the latest available information from the Department of Fisheries and Oceans, there were in 1986 about 3,100 licensed aquiculture operations: 5% cultivated salmon, 29% trout, 55% oysters and 11 % mussels. In 1986, oysters and trout represented 76% of the quantities and 72% of the value of production in the Canadian industry. Trout is mainly produced in Ontario and Quebec, and to a lesser extent in the Prairie provinces. Oyster cultivation is growing significantly on both coasts. On the Atlantic coast, mussel cultivation is becoming a highly significant economic factor, particularly in Prince Edward island and Nova Scotia. Finally, salmon aquiculture is taking on some importance on both coasts of Canada although the major potential growth in this area will be on the Pacific coast' because of the extensive coastline and suitable environmental conditions. According to recent information provided to the Committee, West coast salmonid aquiculture production is expected to increase tenfold to 4,000 tonnes while East coast salmonid production will increase to just over 3,500 tonnes in 1988. Currently, however, the major salmon aquiculture area in Canada is the Bay of Fundy where 1,300 tonnes of Atlantic Salmon valued at $18 million were produced in 1987.

The Department currently projects that by 1995 sales could reach 46,000 tonnes of product, worth approximately $226 million. Of course, much of this forecasted growth will be the result of salmon aquiculture production, which can be expected to develop at least as fast as the Scottish salmon aquiculture industry. It should however be noted that statistical data on the aquiculture industry in Canada are at present limited, as a formal data collection system is being developed and is not yet in operation. Under

the proposed system, the provinces will be responsible for gathering the basic farm information, which the Department of Fisheries and Oceans will then compile annually at the national level.

B. Potential Benefits of Aquiculture Development in Canada

The Norwegian and Scottish experiences with aquiculture suggest that substantial socio-economic benefits can be derived by fostering the growth of this industry. They also suggest some constraints which are discussed in Section "C". The development of the Canadian aquiculture industry has some specific advantages as outlined below.

1. Employment

Aquiculture is able to create a significant number of direct job opportunities for Canadians. The industry's potential for direct job creation is obviously tempered by the fact that it is relatively knowledge — and capital — intensive and requires specific environmental and water conditions depending on the species to be cultured. Direct job creation potential, however, will be supplemented by a significant level of indirect job creation in related service industries such as fish processing, fish feed manufacturing and fish farming equipment manufacturing.

According to the Canadian Aquiculture Producers Council, the growth of salmon aquiculture on the West coast alone has already resulted in the creation of a substantial number of jobs: 113 active farm sites in British Columbia account for 632 on-farm workers and 326 indirect jobs in service industries. The Council expects that the number of direct jobs will increase to 2,700 over the next two years with the number of indirect jobs increasing to just over 1,000. [1]

The Bay of Fundy salmon aquiculture industry with 33 active sites and a production level of 1,300 tonnes in 1987 provided the equivalent of 150 person-years of direct employment and 114 person-years of indirect employment.[2].

The ratios of indirect to direct employment in Canadian salmon aquiculture is lower than the 1:1 ratio commonly advanced in Norway. Two factors can account for this: on the one hand, supplies and services are being imported, since this sector has yet to develop to its full extent in Canada; on

the other hand, it is possible that a more vertically integrated industry may be developing in Canada particularly on the West coast.

2. *Native Economic Development*

On the West coast, a study by Condev Bio-Systems Ltd. has noted that the Native people are "ideal" candidates for aquiculture activities given "their location in the remote coastal regions of British Columbia which provides them with ready access to a wide range of technically excellent aquiculture sites. Their cultural and historical relationship with salmon and the other resources of the sea give them special insight into aquiculture concepts."3 The Committee wishes to emphasize that the long-term involvement of Native people with the Salmon Enhancement Program provides them with valuable experience which could enable them to participate in the hatchery sector of this growing industry. The Committee notes that to date there is seemingly little participation by the Indian people in the West coast's salmon farming industry. This is surprising, given the opportunities the industry could provide and the importance of salmon to Native culture and lifestyles. The Committee saw more evidence of the Native people being involved in the molluscan shellfish industry, either through harvest of wild oysters and clams or in oyster aquiculture businesses. Among the factors cited as impeding the involvement of Native groups in aquiculture activities were: the need for a definite separation between an Indian band's political and business activities and the need for the training of farm management teams and for long-term commitment on the part of the Bands.[4]

3. *Regional Economic Development*

The Committee believes, because of its observations in Norway and Scotland, that aquiculture has great potential as a regional development tool. In Canada, this potential is enhanced by the fact that each Canadian region has its own aquiculture opportunities so that "aquiculture will likely continue to develop as a mosaic in which industry in one region complements rather than competes with that in another. For example, the harsh climatic conditions in Newfoundland can be overcome by concentration on coldwater technology and the raising of such species as scallops."5 It should also be noted that some areas of Newfoundland even offer opportunities for salmon aquiculture. In the Bay of d'Espoir area, water temperatures remain suitable for salmon aquiculture even though the water ices over during the winter. Research is being carried out to overcome

this technical problem. There are many such cases across Canada where technological development will address problems specific to certain areas.

The Committee and the industry do not, however, favour the implementation of legislative restrictions and policies on size and ownership, for regional development purposes. In Norway, such policies have led to disease and environmental problems. Rather, it believes that aquiculture can be made to contribute to such development through proper incentives to develop each region's particular opportunities. Although size, location and ownership restrictions have the advantage of shifting to industry the burden of achieving certain policy objectives, the government must still bear the cost of ensuring the restrictions are enforced. Incentives, on the other hand, imply a cost to government but leave the industry relatively free to develop as it wants; this is especially valuable during the take-off stage of an industry. [t is important that the industry be able to operate without unnecessary restrictions which could either impede financing or prevent the industry from achieving optimal economies of scale.

The Committee believes that the cost to government of providing financial incentives can be kept to a minimum by following certain basic principles. Given that some forms of aquiculture such as salmon farming are an expensive proposition, financial assistance must be directed to those most in need of it; that is, the small entrepreneurs who have difficulties in obtaining financing and who will be running small owner-operated businesses. Both the Norwegian and Scottish models of development have shown that aquiculture can be successfully carried out at the small-business level once the costs of entry into the industry have reached a reasonable level. The Committee is concerned that without assistance, the industry could become dominated by large and/or foreign corporations. Also the level of financial assistance should be proportional to the need for economic stimulus in a particular area; this has been done in both Scotland and in Norway. Simply put, there would be locational incentives similar to those used in the Industrial and Regional Development Program. These would reinforce the natural tendency of aquiculture to develop outside areas that are heavily developed or populated, since it needs a relatively pollution-free environment. As a complement to regional development objectives, particular consideration should be given to coordinating aquiculture development policies with programs that seek to reduce excess capacity in the harvesting sector of the fishing industry: e.g., "buy-back" programs could facilitate the movement of fishermen from fishing to aquiculture or "feed-lot" rearing of seasonally available marine fish.

4. *Other Benefits of Aquiculture Development*

Aquiculture development will result in many social and economic benefits, which may not always be as tangible as direct job creation in economically depressed areas.

Among these benefits, there will be increased R&D activities and technological developments related to aquiculture. In Norway, the aquiculture industry has shown itself profitable enough for the government to invest considerable amounts of money into state-backed research activities. This may have been as a result of the Norwegian industry being composed of many small producers unable to carry out in-house R&D. With the exception of the in-house R&D activities of a few large Norwegian firms and research contracted out to private and governmental research institutions by large firms and producer associations, aquiculture R&D is led by the Norwegian government. In Canada, aquiculture research by government has been to a large degree responsible for the development of the industry to date. In the future, there will be an increasing need for government research efforts to be focused on regulatory requirements (such as site location, environmental effects, disease control and product inspection) and on longer term issues of potential importance such as the biology of new candidate species. In addition to government research, there are clear advantages to be gained by allowing development of large aquiculture firms with in-house research capabilities and by industry's contracting out research to government and university laboratories. Smaller companies and individuals will still require the knowledge base and information provided from governmental aquiculture research programs.

Another benefit of aquiculture development is the symbiotic relationship which can develop between the fishing and aquaculture industries and related service industries.

For example, the development of aquiculture will increase capacity utilisation rates in the processing sector of the traditional fisheries by increasing the supplies of raw material for the preparation of intermediate or final products. It is also clear that aquiculture development will increase the demand for under-utilized species in the traditional fisheries as the basic ingredients in fish feeds; in Norway, 64% of the fish landings are for industrial use rather than for human food. It is estimated that up to 30% of these landings are used in the manufacturing of fish feeds for salmonid aquiculture.

The aquiculture industry will complement the wild fisheries by improving the quality and continuity of the supply of Canadian fisheries products both domestically and internationally. Traditional fisheries should benefit from aquiculture production as the markets for all fisheries products expand. A particularly interesting example of the symbiotic relationship which can occur between the two industries is a type of aquiculture being developed in Newfoundland. Live cod caught in the in-shore trap fishery during their summer migration are transferred to sea-cages where they are fed and fattened for marketing at a later date. This type of activity demonstrates a number of interesting advantages such as providing cod fishermen with an additional outlet at possibly higher prices and a stabilizing factor in the offer of fishery products.

Canadians have never consumed large quantities of fisheries products although per capita consumption figures have been steadily rising over the past decade. In addition to cultural factors, a number of reasons for this low consumption rate can be advanced. Supply often varies substantially according to season and there are distribution and transportation problems in making fresh fish available in a country as large as Canada. As a result, the Canadian domestic market has been often serviced as a residual market by the traditional fishing industry, especially as export markets provide the highest returns.

The aquiculture industry has the potential to complement the traditional fishing industry as a year-round supplier of varied and quality products. Aquiculture can help expand the domestic market for fish products by overcoming the distribution and transportation problems of supplying fresh fish to consumers. Some types of aquiculture could conceivably be carried out near major population centres far from the coast. This is already being done to some extent by trout farmers in Western and Central Canada. Aquiculture may also help to stabilize, possibly at higher levels, the prices of certain fishery products, given that continuity and quality of supply are major factors in the determination of such prices.

C. The Constraints and Requirements of Aquiculture Development in Canada

This section documents the constraints that are causing the slower growth of aquiculture in Canada and sets out the requirements for accelerating growth. Among the factors often cited as retarding the growth of aquiculture in Canada are our cold-water environmental conditions and the

plentiful wild fisheries resources available to the Canadian fishing industry. More likely explanations seems to be the lack of clearly defined jurisdictions, inadequate support policies, limited funding and the lack of clear ground rules for the development of the industry, as well as the limited availability of high risk investment capital.

1. Jurisdiction, Legislation and Regulation in the Aquiculture Industry

Aquiculture falls into a grey zone between the federal responsibility for fish, fish health and habitat, environment, fisheries management and product inspection and navigational waters, and the provinces' responsibility for resources and proprietary rights. The question of jurisdiction is complex for any new industry, but it is particularly so for aquiculture. This section covers the jurisdictional issue, the federal/provincial agreements on commercial aquiculture development and the legislative as well as regulatory requirements of the industry.

a) Jurisdiction

In Canada, the federal and provincial governments both claim jurisdiction over aquiculture and both levels of government have been regulating some aspects of the industry.

The federal government bases its claim on the fact that under the *Constitution Act*, the **"seacoast and** inland fisheries" and their management are its responsibility. The federal government regulates aquiculture under the *Fisheries Act* and implicit in this is that aquiculture is a natural extension of the fishing industry. This is a matter of some debate as it has been argued that aquiculture should rather be the subject of a National Aquiculture Act "to set out the federal role in aquiculture and be the enabling legislation" for the industry's regulation by the federal government.[6] The arguments in favour of this position are outlined in the next paragraph. Among the factors that militate against the adoption of such a statute are: on one hand, it contradicts the federal government's position that aquiculture is a type of fishing activity; on the other hand, it could jeopardize the uneasy federal-provincial relations in this area by antagonizing provincial governments who might see it as a move by the federal government to strengthen its jurisdictional claim over this activity.

According to Bruce Wildsmith, a Canadian jurist who has worked for the provinces and the federal government on the legislative and regulatory

aspects of aquiculture, the aquiculture industry in Canada has come of age. Consequently, it is important for its future development that it be recognized legislatively as an activity that is different from fishing. For Wildsmith, accepting aquiculture or fish cultivation as a fishing activity is of doubtful value. Separate aquiculture legislation would prevent the application of irrelevant fisheries regulations such as seasonal harvesting restrictions to the aquiculture industry. It would also clarify the federal government's role and help develop a coherent, uniform and comprehensive approach through a consolidated body of regulations for the aquiculture industry.

Provincial governments argue that aquiculture is a matter of "property and civil rights" or of "local works and undertakings" within the province. For example, in Nova Scotia, aquiculture falls under the 1983 *Nova Scotia Aquaculture Act* which was the first legislation of its kind in Canada. A number of other provinces such as **Quebec** and Newfoundland have since promulgated their own aquiculture legislation.

b) Federal-Provincial Memoranda of Understanding

There are merits to the positions of both levels of government and it is to the credit of each that, instead of challenging the jurisdictional claims of the other in the courts, each has made efforts to negotiate federal-provincial memoranda of understanding on aquiculture development. The two major objectives of these agreements are: 1) to have one-stop aquiculture licensing and leasing procedures administered by the provinces and *2)* **to** ensure federal-provincial cooperation in the interest of an orderly development of the industry. To date, agreements have been signed with Nova Scotia, Quebec, Prince Edward Island, and Newfoundland; negotiations are on-going with British Columbia and soon to take place with New Brunswick.

The MOUS signed to date have confirmed that federal regulation of aquiculture will continue to rest with the *Fisheries Act* and that the means of regulation will be a licensing and leasing system administered by the provincial governments. The Nova Scotia and Quebec MOUS provide that the federal government will enact regulations under the authority of the *Fisheries Act* to facilitate the provincial administration of the licensing and leasing of aquiculture facilities in accordance with federal regulations and whatever additional requirements the province sees fit to impose. This constitutes a delegation of authority leaving the provinces in charge of licensing, site leases and, by extension, regulating and enforcing compliance of the terms and conditions of the licence. This brings the situation in line

with that which exists in the inland provinces, where there has not been a double licensing requirement for aquiculture, since the administration of inland or freshwater fisheries has already been delegated to the provinces.

The Agreements also provide for the creation of joint (federal and provincial) Aquiculture Coordinating Committees to implement the MOUs. In Nova Scotia, the industry is given formal representation on the committee but this is not the case in the agreements signed with the provinces of Quebec and prince Edward Island. In New Brunswick, an Aquiculture Coordinating Committee established since 1985 has federal, provincial and industrial representation. The MOU being negotiated with the BC provincial government should provide for direct industry representation.

One of the first tasks undertaken as a result of the Nova Scotia MOU was the drafting of the federal regulations for inclusion in the Nova Scotia Regulations under the *Fisheries Act.* The Department of Fisheries and Oceans initially hoped that the Nova Scotia regulations would serve a model of federal regulatory requirements in provinces entering into an aquiculture development agreement with the federal government.

The Committee notes that the federal/provincial negotiating process that was to establish federal regulatory requirements for aquiculture in Nova Scotia is at present stalled. This is due to the provincial government's reluctance to have the Department of Fisheries and Oceans exercise its mandate by approving all aquiculture applications which, because of their location, could pose a significant danger to the conservation and protection of wild fish, its habitat and its health or represent a fisheries product inspection problem. The implication of this situation is that the provincial government wishes to be the sole judge of whether federal concerns are addressed, while the federal government wishes to ensure its legislative responsibilities are achieved.

In short, while the federal government endorses the concept of a single licensing/leasing authority administered by the provincial authorities, this can only be readily accomplished by implementing an inter-agency referral process whereby all federal and provincial agencies, with a legislative mandate relevant to aquiculture development, will be able to review and provide comment on each application within a reasonable period of time. [n cases where unacceptable interferences would result with fisheries resource conservation and protection, fish habitat, etc. the Department of Fisheries and Oceans would not approve the application and no license would be

issued. A parallel federal example would exist if, for navigational waters protection purposes, an exemption was not granted by the Ministry of Transport, a site lease would not be granted by the province. The Committee is of the opinion that every reasonable effort must be made to encourage aquiculture development. In consequence, the federal government must ensure in its agreements with the provinces that nothing interferes with this objective especially as relates to the issuing of aquiculture permits.

In British Columbia, negotiations on an aquiculture MOU are fairly advanced. There remain however a few fundamental disagreements on the respective roles of both levels of government vis-à-vis the aquiculture industry that will in all probability only be resolved at the ministerial level. For example, a fundamental disagreement flows from the BC government's position that the federal government cannot delegate authority that it does not have, such as allowing or preventing an aquiculture project to proceed, this position being based on the belief that aquiculture is not a fishery. The Committee recognizes the need for the federal government to continue to exert its jurisdictional powers to conserve and protect the fishery resource as well as fish habitat and health. A recognition of this jurisdiction and responsibility should be the basis of all aquiculture MOU'S and agreements with the provinces.

53. During its meetings with industry representatives, the Committee heard repeated calls from industry for speedy finalization of these agreements, thus removing a major impediment to aquiculture development, the lack of clearly defined jurisdictions. This lack results in the duplication of government activities, deters the development of adequate support policies and makes it difficult for the industry to know the level of government to address when seeking advice on technical, scientific or financial problems. It also inhibits spending in support of industry as governments generally seek to keep their spending in their own areas of jurisdiction to ensure that they receive full political credit.

c) Industry Regulation

As a result of the industry's current stage of development, there is lack of regulation; for example, salmon farmers are not subject to Health and Product Safety Regulations such as those applying to farmers in agriculture. There are no government standards for the time required to ensure that salmon has eliminated any medication before being marketed. In the absence of the necessary scientific knowledge to resolve this situation, the BC

Salmon Farmers Association (BCSFA) and other salmon farmers in Canada have adopted American-set standards for this, of 45 days. However, this standard is not enforced and there are indications that some farmers use a 21-day period. Net and equipment manufacturing, the use of anti-foulants on nets or pesticides applied directly on the fish, the composition and nutritional quality of feed, are other areas where standards have not yet been established.

The industry often states that it should be self-regulating in these respects. This may suggest an idealistic attitude but in fact the main preoccupation of the industry is to ensure reasonable profits and avoid being saddled by excessive, rigid, and conflicting regulations at different levels of jurisdiction. A major concern of the industry is to have input into the regulatory process. As a means of ensuring this, representatives of the industry (nation-wide) have been in contact with the Canadian General Standards Board (under Supply and Services) to discuss the establishment of industry standards. This initiative has however been temporarily postponed on the basis that it is too early for such action in the development of the industry and due to the lack of the necessary scientific information for the establishment of meaningful standards.

The need to establish standards for aquiculture equipment and products is apparently recognized by the federal and provincial governments, which think that the establishment of industry standards developed on a consensus basis will help government regulators. However, the establishment of standards based on consensus is a second-best solution that can last only as long as the necessary scientific knowledge is lacking.

The research and development necessary to obtain this knowledge must be one of the first priorities of governmental research: into, for example, the time required for the elimination of drug residues from fish flesh, and the potential for bioaccumulation of chemical pesticides that could be used in fish farming. Such questions and many others especially in the areas of fish disease, genetics and the environment, must be answered on a priority basis before intensifying long-term government research into future aquiculture candidate species. This will enable the development of an industry able to benefit from such long term research and exploit it commercially.

The present government regulatory approach is to wait for the manufacturers of these trade-mark products to come forward with the

necessary data on such questions so that their products can be certified for use in aquiculture. However, these manufacturers will not engage in such research unless there is a possibility of a profitable market. The industry is still relatively small and these products (especially the medical ones) will be used in such minute quantities that there is not much chance that the manufacturers will become involved. Government research has a responsibility to fill this basic knowledge gap on potential contaminants, deficiencies in feeds, biologics, etc. on a generic basis which would focus on the active ingredient contents of trade-mark products.

Other areas requiring government regulation and research are the effects of aquiculture on the environment and the effects of these environmental changes on the health and production of both wild and pen-reared stocks. This requires mandatory environmental data monitoring programs, public liability insurance and substantial site clean-up bonds as conditions of tenure. Industry participants have stated that they recognize the need for environmental controls and that they can benefit from them. They fear, however, that the results of some studies will result in the selection of aquiculture areas far removed from population centres; this would create problems for the industry in terms of access to supply and services. As well, the closer the industry is located to densely populated areas with high use of resources for recreation, the more stringent pollution controls regulations will have to be; this would entail higher operating costs. It can only be emphasized that in selecting areas for aquiculture purposes through coastal resources surveys, the environmental loading capacity must be identified and used as the primary criterion. Secondary criteria would include such things as resources-sharing with other users. It is clear that to minimize the opposition of other resource users to aquiculture development the density of farms must be kept low and their visual impact minimized. In addition, a control of the density of farm units is likely to be found to have a positive effect on pollution levels and fish health.

2. *Financing the Industry's Development*

a) Industry Financing and Capital Requirements

The Canadian aquiculture industry is in desperate need of working capital loans. For example, the capital requirements for the development of the salmon farming industry in British Columbia alone are estimated to be above $100 million over the next two years. Of this amount, over $20 million could be required simply to cover feed costs, the farmers' largest single operating expenditure, representing possibly up to 40% of total

operating costs. The industry will have difficulties in meeting its capital requirements unless a loan guarantee program is set up by government. Loans to the industry covered by such a program will have to be tailored to take into account the negative cash flow of the first few years of operation. This is due to the lengthy growth and harvest cycle typical of most sectors of the aquiculture industry. As well, any government sponsored loan guaranties should require appropriate crop insurance as a condition of access.

Some financial assistance has been made available to the BC industry through the Aquiculture Incentive Program under a subsidiary agreement of the federal-provincial ERDA. This program provides interest-free capital loans of up to a maximum of $100,000. There are, however, problems with this program which illustrate the difficulties most governmental programs present for the aquiculture industry.

First, it only applies to capital loans, which are not the major financing problem of the industry. Banks are apparently willing to finance capital loans for the purchase of equipment which they can easily foreclose on, and liquidate. In addition, the Norwegian aquiculture suppliers make financing assistance available to purchasers which is why many West coast aquiculture businesses have purchased Norwegian equipment. It should be noted that the BC industry's inability to finance itself domestically is reported to be leading to increasing levels of foreign ownership (particularly Norwegian), something which could dissipate some of the benefits of aquiculture development. For example, this could mean that less R&D activities will be carried out in Canada and that the aquiculture supply and services industries will develop more slowly as fish farming equipment continues to be imported from Norway.

Secondly, there is a question as to whether the program is sufficient in light of the industry's projected growth of up to 250 salmon farms by 1995. To date, $4.0 million in loans have been made available to 59 aquiculture companies, including some oyster growers.

In New Brunswick, a similar program (the Salmonid cage-culture program) was put in place under a subsidiary agreement on fisheries development. This program has made available $2.1 million in grants for selected capital and operating expenditures to 21 companies in the Bay of Fundy since 1985. Presently, the total number of salmon farms in the Bay of Fundy is 33 compared to approximately 120 in BC. The lower number of sites in New Brunswick is partly related to a moratorium imposed to govern

the rate of growth of the industry. This moratorium will be lifted in the fall of 1988 at which time pending applications will then be reviewed for site leases. The bottom line is that, at least in BC, government financial assistance is simply not providing sufficient leverage for the financial institutions to move in and contribute to meeting the industry's capital requirements. It should be noted that the sales value of the Bay of Fundy production increased from $675,000 in 1983 to $18 million in 1987 which illustrates the type of cost-benefit ratio this industry can achieve with respect to government expenditures. It is also interesting to note that more banking sector involvement is reported in New Brunswick due to the industry establishing an undeniable track record as well as a result of decisions made by regional bank managers familiar with the industry.

Given that the major production costs of a salmon farmer are for feed, supplier financing would seem to be the appropriate solution, assuming that some feed suppliers are large enough to carry out such activities. Feed suppliers are, however, reluctant to supply credit over a lengthy growth cycle, and, as rightly pointed out, could do so only by increasing feed costs. Farmers are also reluctant to become involved in deals of this type (where, in the last stages of the growth cycle, credit lines are supplied in exchange for a portion of the return on the crop) as these have usually worked to the disadvantage of the participating farmer.

Aquaculturists have raised problems relating to investment Tax Credits. This taxation provision permits a deduction from federal income tax for the acquisition of qualified depreciable property to be used in manufacturing, processing, farming, fishing, logging, mining and grain storage. There are no impediments to an aquiculture enterprise's benefiting from this provision. However, changes contained in the 1986 Budget now limit the extent to which ITCs can be allocated to limited partners. This change applies across the board to all industries, but, for the developing aquiculture industry, already beset by financing problems, it creates an additional difficulty in attracting risk capital. On the positive side, the refundability of ITCs for small corporations and individuals has been extended indefinitely in the recent Tax Reform. This is of particular benefit to small firms, especially in their start-up phase where negative cash flows are a problem. Refundability is in effect a form of financing. Tax Reform, however, ended the refundability of ITCs for the larger corporations, something which may unfortunately cause problems for the larger aquiculture firms.

The ITCS also include the Special R&D Credits which apply to capital and current expenditures on R&D, such as the salaries of researchers. Business in general has long complained about the drawn-out procedures required to obtain this tax credit. Fish farmers have, however, apparently had additional difficulties in using this taxation provision due to the lack of guidelines from Revenue Canada on what constitutes R&D in fish farming. Participants believe that, as a developing industry, aquiculture is involved in R&D on a daily basis.

Some fish farmers have mentioned that, considering the Federal Business Development Bank's mandate, it should be more responsive to the needs of the aquiculture industry. The bank offers a number of programs that would presumably be of substantial relevance to the aquiculture industry: a loan guarantee program, term loans, and a venture capital program whose object is to help finance companies with high growth potential but little access to capital markets. It seems that these programs would have to be adjusted to meet this industry's rather unique requirements. It should be noted, however, that a loan program to assist mussel growers was recently implemented and it is to be administered through the FBDB.

b) Banking Sector Views on Aquiculture Financing

The banking industry in British Columbia recognizes that aquiculture has the potential to become very significant in the economy of British Columbia within the next decade. It qualifies this, however, by stating that its potential will only be realized if all limiting input factors relating to infrastructure, management expertise, production techniques, financing and markets are identified and resolved on a sound long-term business basis. The specific factors cited by the banks for limiting their involvement in the financing of the industry are as follows.

As the BC industry has not yet completed a full crop growth and harvest cycle, it has not established an operational track record. As a consequence, there is a lack of normative financial data which could be used to assess the operational feasibility and credit-worthiness of entrepreneurs involved in aquiculture. This problem is apparently being addressed jointly by the BCSFA and the Ministry of Lands and Forests; they are collecting data needed to develop financial ratio norms for the industry, for example, the ratio of feed costs to total operating expenditures for various sizes of profitable farms. The banks have indicated their willingness to assist in this respect.

Another problem identified by the banking community is inventory assessment and insurance coverage for aquiculture. There are at present no widespread, reliable and efficient means of determining the number of fish as well as the biomass and reliable inventory counts constitute the basis of inventory financing. This is a major difficulty in an industry beset by substantial inventory variance and high mortality rates. However, the development of inventory-taking techniques using video-camera equipment should reduce this problem. Insurance coverage is also an integral part of inventory financing. To date, this has been available in Canada for fish mortality due to diseases and plankton blooms, but the banking industry is more concerned with a problem which has not yet occurred: the possibility that insurance companies might reduce the coverage of fish farmers, as in Norway, where insurance companies have tended to reduce the coverage by instituting a higher degree of co-insurance and risk-sharing. In response, the industry emphasizes that underwriters have to date been satisfied with the inventory control practices of firms whose shares they have carried.

The above problems are related to the changes pending for section 178 of the *Bank Act.* In the current wording, aquiculture is not specifically named and the collateral (such as penned fish) which could be used in financing an aquiculture venture is not clear. It is expected that the next revision to the *Bank Act* will clarify this situation. This will not, however, solve all impediments to bank financing of aquiculture, especially those outlined above.

Another apparently serious deterrent to bank financing of aquiculture is the leasing system. The banks are concerned that the lack of transferability of aquiculture leases could hinder the orderly disposal of assets. While there is no move on the part of government to allow the unfettered transferability of leases, discussions are underway between the banks and the BC Ministry of Lands and Forests to achieve a mutually acceptable non-disturbance agreement.

The bottom line for the banking industry is that aquiculture is a high-risk industry, particularly with respect to the BC industry's current development stage, and that the security margin normally required for bank loans to any industry is absent. It was pointed out numerous times to the Committee that the involvement of Norwegian banks in their domestic industry was and still is encouraged by the risk-sharing activities of the government. Also, aquiculture entrepreneurs emphasize that the use of loan

guarantees to assist the development of an industrial sector is not without precedent.

The banking industry accordingly stresses that a loan guarantee program (as opposed to direct lending) is required to involve the banks in the development of the industry. It envisions a program

> "tailored to the industry's unique requirements particularly in its current stage of development. Viable parameters should be established in order to provide guarantees for appropriate levels of capital and operating advances. The program should be directed to smaller operators whose financial requirements to not exceed $1 million and it should be directed towards those able to put up a tangible level of equity, to provide a sound business plan and to demonstrate a reasonable amount of expertise to ensure favorable long-term financial prospects.'"

The level of loan guarantees sought by the banks, however, is not clear, but the fact that the program envisaged calls for guarantees on capital expenditures shows that the banks wish to have their risks reduced to nil. They have said they are prepared to assist in the development of such a program which could be elaborated through negotiations.

3. ***Aquiculture: Fishery or Agricultural Pursuit?***

The Committee heard many representatives of the aquaculture industry, asking for the recognition of aquiculture as an agricultural pursuit rather than an extension of the traditional fishery. The major reason for this is that members of the aquiculture industry feel that they have not received enough support from the Department of Fisheries and Oceans, with the exception of help with scientific research. The aquiculture industry has concluded that DFO'S attitude towards it is conditioned by its mandate, which is mainly to manage a common property resource through the regulation of harvesting. The industry and most provincial governments maintain that aquiculture is an agrarian pursuit involving proprietary rights over fish.

Some aspects of this claim are valid. In addition to involving proprietary rights over fish, the industry is crop oriented and therefore parallels agriculture in production and marketing operations notwithstanding the particularly long growth cycle. However, until such time as sufficient supplies of domesticated broodstock are available, aquiculture must rely on wild stocks and their aquatic habitat to operate. Most countries do include legislative responsibilities for aquiculture with fisheries and often fisheries

(including aquiculture) and agriculture are combined as a "food" ministry. [n essence, aquiculture can be said to be both a farming-based activity and an extension of the fishing industry, at least for the provision of broodstock and in the use of a common growth medium (i.e. the aquatic environment) which also happens to be a common property resource. As one moves through production into the transformation and final marketing stages, the distinction becomes even less clear as both industries supply fisheries products to the consumer.

Accordingly, consistent regulatory treatment of both fish production systems, natural or cultured, is necessary if optimum benefits are to be derived from them. A further recognition that some specific needs of the aquiculture industry may be closer to agriculture than to the commercial fisheries is also necessary. This will require an adaptation of some of the activities and programs of the Department of Fisheries and Oceans in the areas of seed stock supplies, R&D, extension services, product inspection, fish health and general support of aquiculture through fisheries development programs. It may also mean involving the Department of Agriculture in the delivery of programs to the aquiculture industry or expanding the activities of the Department of Fisheries and Oceans into totally new areas such as crop insurance.

4. Interactions and/or Conflicts With Other User Groups

Aquiculture development has inevitably lead to some conflicts. While some of these conflicts are a matter of perception, some of them are very real. A notable fact about these conflicts is that they vary tremendously between regions and across user groups although some concerns are jointly shared by some groups such as the commercial and recreational fishermen leading to a coalition of various interest groups against unregulated and unsurpervised aquiculture development.

[t can be expected for example that commercial fishermen will continue to oppose aquiculture development until such time as their concerns with it are put to rest. This is particularly true in BC where there is a large commercial salmon fishery concerned with salmon aquiculture development. The concerns of commercial salmon fishermen include the following: aquiculture as a source of pollution endangering the wild fish habitat, increased scarcity of funds for fish habitat improvement and stock enhancement programs (e.g. SEP) as more resources are directed to aquiculture development, the danger of genetic "pollution" if escaped farmed

fish should mate with wild stocks as well as the danger of diseases being transferred from farmed fish to wild stocks.

While such concerns are not, by any means, to be taken lightly, it must be noted that there is no substantive scientific evidence to support some of these concerns such as the one related to genetic pollution. In the case of other concerns relating to pollution, diseases and destruction of wild stocks and their habitat, the Committee is convinced that DFO has at its disposal the legislative mandate and the necessary regulatory tools (such as the Fish Health Protection Regulations) to satisfactorily meet such concerns. The Committee is, however, not convinced that DFO has at its disposal, the financial resources to satisfactorily meet all such concerns. In some cases such as the supply of salmon eggs to the BC salmon aquiculture industry, DFO has clearly demonstrated its zeal in protecting the wild fishery which should put to rest concerns such as the depletion of wild stocks due to the use of wild seed stock for aquiculture.

Also, it must be remembered that fish farmers have a vested interest in maintaining clean waters for the health of their own stocks and that the best way of ensuring this is to locate farms in areas with sufficient water flushing action. As well it should be noted that shellfish growers are a sector of the industry which is particularly dependent on clean waters and very strident in its calls for increased monitoring and protection of water quality. It is interesting to note that molluscan shellfish are filter feeders which can even contribute to an area's water quality level. However, the Norwegian experience with salmon farming has shown that notwithstanding the farmers' self-interest in maintaining clean waters, it will be necessary for government to introduce regulations in this respect at some point in time as pressure is created for the opening of additional sites for fish farming in areas which may not necessarily be suitable to such activity.

In Atlantic Canada, the absence of a full-scale commercial salmon fishing industry reduced the opposition to salmon aquiculture development although concerns about genetic pollution exist among recreational fishermen. It should be noted that the Atlantic Salmon Federation, notwithstanding its concerns about the potential impact of genetic pollution, is a strong backer and participant in aquiculture development in the Bay of Fundy.

It is likely that DFO will eventually have to review the Fish Health Protection Regulations to ensure that they do not needlessly impede

aquiculture development by preventing the movement of live fish and eggs within Atlantic Canada for example. Such a review, if carried out, should not however reduce the protection afforded the wild stocks by these regulations. It should be pointed that on going research and development into the production of sterile fish could eventually lead to the widespread use of sterile farms stocks in areas where disease transmission and genetic pollution are a concern.

Concerns about aquiculture among commercial fishermen are however not limited to salmon fishermen. For example, in Atlantic Canada, in the Bay of Fundy area, some presently non-productive herring weir fisheries are located in areas suitable for aquiculture operations. While this is a good example of competition for available space between the two industries, policies can be drawn up to ensure that herring weir fishermen get priority assistance in setting up aquiculture operations in these locations. This possibility, initially raised by some fishermen, is apparently receiving increasing support. Other conflicts between the two industries may arise if aquiculture development restricts access to other trap fisheries such as the lobster and crab fisheries or to inshore bottom fishing grounds for scallops and some groundfish species. However, this type of situation can be easily prevented by ensuring that DFO is able to fulfill its legislative mandate in the inter-agency referral process for aquiculture licencing and leasing operations. It is even possible that a strong community of interest will arise as a result of some types of aquiculture development. For example, in Newfoundland, it has been pointed out that the development of cod farming by transferring live cod from the inshore trap fishery to sea-pens depends on the continued maintenance of a strong inshore cod fishery which has strong social importance in that province. While such a community of interest is initially surprising, it really only illustrates that the two industries are not that far apart in terms of both their final objectives and requirements.

Aquiculture development also draws opposition from a number of groups other than the commercial fishing community such as wildlife and nature groups, shoreland owners, etc. In Nova Scotia, a solution to this was attempted by instituting a public consultation process within the licence application system. Problems associated with the consultative process in Nova Scotia led to its breakdown. It proved expensive to operate and led to often acrimonious confrontations between user groups with the licence applicant having to defend his project before opposing user groups. It should be noted that this is much like the situation in Scotland where the public consultation process was marred by acrimonious debates due to the lack of sufficient scientific knowledge about the actual impact of aquiculture in terms of

pollution etc... It should also be noted that the situation in Scotland is also complicated by a lack of sufficiently clear and comprehensive zoning and siting regulations.

The Committee notes that more successful procedures have been followed in both New Brunswick and British Columbia. The New Brunswick moratorium was imposed in 1986 to allow commercial smelt production to catch up to grow out capacity and to moderate the growth of the industry in relation to the development of regulatory procedures. In late 1986, the BC provincial government imposed a moratorium on further aquicultur, development in the face of growing opposition. At the same time the BC provincial government commissioned a public enquiry into finfish aquiculture. While the Gillepsie Commission of Inquiry did not solve all problems related to aquiculture development, it did lead to substantial improvements in the land allocation and disposition methods used fo, handling new aquiculture licence and lease applications. This has in turn contributed to the better siting of aquiculture operations. As well the public consultation conducted by the BC Inquiry into fish farming contributed to dispelling many unfounded fears related to aquiculture development resulting from insufficient and often incorrect information.

This suggests that a public consultation process is more productive when conducted to obtain public input on concerns related to aquiculture development which can then serve as the basis for elaborating adequate zoning policies in addition to improving the circulation of scientific information on aquiculture.

However, a means of ensuring that concerned user groups are able to express their concerns on aquiculture development taking place within their community is also necessary. This can be done by implementing referral and notification mechanisms within the licencing application and approval process. Such mechanisms make it incumbent on the authorities to notify concerned interest groups of aquiculture licence applications which may affect them. Such mechanisms can be implemented at two levels. It is possible for example that the authority in charge of administering the licencing system and approving licence applications could be the agency designated to implement the referral and notification mechanisms to ensure the input from concerned user groups. However, this agency already has the responsibility of administering the inter-agency referral mechanism talked about in the section of the report which deals with the federal-provincial MOUS. [t is thus preferable that the agencies having to provide input into

the inter-agency referral system be made responsible for the notification and referral of aquiculture applications to the concerned user groups which are their constituency. For example, a municipality who is asked by the licencing authority to comment on a aquiculture application could notify concerned interest groups such as upland owners and if required hold a public meeting for informational purposes. In this way, its comments to the licencing authority would reflect the concerns of its constituency but the decision as to whether an aquiculture project would proceed would rest with the licencing authority. This decision should of course be consistent with local zoning regulations. ideally, the comments of the municipality would be based on a clear and comprehensive zoning framework in much the same way that DFO would be expected to comment on an aquiculture application based on a clear regulatory framework which would enable it to assess whether the aquiculture project is potentially harmful to the fishing activity taking place in the same area.

5. Research and Development

a) DFO's West Coast Aquiculture Research Program

The Committee has seen much evidence of the commitment to aquiculture research among the scientists working at the (Nanaimo) Pacific Biological Station and the (Vancouver) Centre for Genetics and Biotechnology in Aquiculture. These two organisations which are part of the Biological Sciences Branch of DFO have been involved in aquiculture related research for over two decades.

The earlier research efforts of the Biological Sciences Branch on both coasts dealt with such topics as the effects of temperature on salmon growth, net pen rearing, the development of vibrio vaccines and the effect of stress on salmon. There was also research into oyster culture and sablefish and halibut culture, like that which is now being pursued intensively in Norway. These earlier Canadian research efforts provided a wealth of information for the developing aquiculture industries of Norway and Scotland.

Current research efforts by DFO's Biological Sciences Branch are two-pronged.[8] First, is research to solve problems of immediate interest to the industry, such as fish health, nutrition, photo-period control of smoltification, strain evaluation and selective breeding; second, is research to further the long-term development of the industry by providing new technologies to increase the Canadian aquiculture industry's competitive

edge. This type of research includes: the examination of new candidate species for aquiculture, the production of genetically identical high quality fish and the production of monosex (female) and sterile fish stocks. As noted by a DFO scientist, aquiculture is a newer industry than agriculture and animal husbandry and is only in the first phase of the domestication of a wild species. Even so, R&D efforts have resulted in the development of technologies such as monosex culture which are not yet available in the beef and poultry industries. This would tend to show that current aquiculture R&D efforts are mission-oriented contrary to the claims of industry and the BC provincial government.

On the one hand, the industry seems persuaded of the importance and quality of the R&D being carried by DFO scientists; on the other hand, it seems to believe that these R&D efforts are directed to solving long-term problems only, and that not enough efforts is, being put into what it considers to be its immediate needs. There is a problem of perception on the part of the industry and a problem of communication on the part of government scientists.

The industry's ambivalent attitude towards DFO Pacific Region R&D efforts may result from a misperception of the nature of research. Industry participants are inclined to think that the time required to solve a problem is inversely proportional to the amounts of money used to address the problem and therefore rather simplistically divides aquiculture research into a short-term/long-term dichotomy which has no factual basis. Other factors are also involved in determining the results of research activities, such as the quality of the research, which is often a function of the time spent on a project, and the nature of the problem being researched. Medical research into cancer is a good example of this: increasing amounts of money have not resulted in the development of final solutions to this problem. Even though bacterial kidney disease (BKD) is currently the salmon farming industry's biggest problem, causing annual losses of about $5 million, the industry cannot expect that putting all research funds into BKD research would necessarily result in an immediate solution. In addition, such action could jeopardize valuable research (such as that on nutrition) currently being carried out to ensure the long-term development of the industry. For example, it was pointed out that research. aimed at developing cheap but effective diets, only costs about $150,000 annually but could result in savings of up to $3,000,000 annually at current production levels. At future production levels, the cost savings could run into the tens of millions of dollars. As well, basic research in one area leads to benefits in other areas. For example, nutrition research can lead to improved knowledge of fish

health as the link between the two subjects becomes clearer: some experiments show that it is possible to reduce the incidence of BKD by modifying fish diets.

The fact that the Norwegian industry's development was at least partly based on technology transfers initially reduced the need to carry out basic research. For example, basic research into fish health seemed to have been neglected until substantial expenditures were required (by both industry and government) to solve an urgent health problem such as the Hitra disease. The Norwegian government recently reaffirmed its commitment to aquiculture R&D, when it realized that basic government sponsored research would prevent threats of widespread loss of crops and, in the longer-term, the erosion of its industry's competitive edge. This could be avoided in Canada by having governments commit themselves to aquiculture R&D responding to both immediate problems as well as longer term requirements. Favouring one at the expense of the other can only lead to problems at some point in the future.

In British Columbia, the Department seems unable to convince the aquiculture industry that its research activities are mission-oriented, applied and problem solving as well as of commercial relevance, rather than simply an adjunct to research on the wild fisheries. The most fundamental reason for this is the lack of sufficient resources to provide research extension services. As long as the means of transferring knowledge from the scientific domain (the laboratory) to the practical domain (i.e. the farm) are lacking, this situation will continue. DFO must commit itself to providing new resources for research extension services to industry. This means in part appointing biological extension officers who would provide both expertise on which the industry could draw and a link between scientists and the industry. One industry participant suggested that those delivering extension services should also be involved in the determination of R&D funding priorities. An industry expert suggested that field extension representatives would be of the utmost importance in the aquiculture industry, which is often located in remote areas.

There is no reason why the level of government engaged in research activities should not also assume the responsibility of transferring the resulting technology. The only real reason for the provincial government to assume an exclusive responsibility for such extension and technology transfer services should be that the federal government is unwilling to commit the necessary resources to accomplish this. Should both levels of government be

unable to agree on who is to be responsible for extension services and both engage in their own extension activities, it will be necessary that the respective areas of competence of each agency be clearly delineated and that the extension services of both be complementary. Some type of coordinating mechanism, such as the Aquiculture Co-ordinating Committees, will be necessary in this respect. As well the BC provincial government may wish to consider increasing its own research efforts to serve as the basis for its own extension activities.

The Committee has heard repeated calls from industry for aquiculture research and development to be funded on private farms to ensure that it is of commercial relevance and scale. While such a proposition has merit when the research has specific short-term objectives, such as the development or adaptation of new equipment, there are disadvantages to carrying out some types of R&D on private sites. Scientific research must more often than not be carried out in controlled situations to ensure stringent data collection and to avoid in some cases the spread of diseases or the interruption of experiments because of cash flow problems. The Unsolicited Proposals Program of the Department of Supply and Services is a possible channel for funding private aquiculture research. Unfortunately the DSSUP program requires DFO funding, albeit at 20-30% of the total research cost, it remains, however, often times more than DFO can afford under present circumstances. This program is also of short duration with DSS only providing "bridge funding" for the first year and DFO having to assume full costs if the project is to continue beyond that. Over the past five years, out of the 195 contracts (valued at nearly $30 million) undertaken across Canada under the DSSUP program with DFO support, about 17% were aquiculture related: technology development, fish health, nutrition genetics, physiology, etc. Another possible channel for funding of private aquiculture research is the National Research Council's Industrial Research Assistance Program, which helps support small research projects which frequently involve DFO scientists as project advisers.

The best way of ensuring that aquiculture research and development is carried out on a commercial scale and is of relevance to the industry is to establish and strategically locate on the West coast at least one government sponsored experimental (finfish and shellfish) aquiculture' farm to support the development of the aquiculture industry in much the same way that experimental farms have achieved technological advances in the agriculture sector. The benefits of such an approach have been amply identified with the Salmonid Demonstration and Development Farm (SDDF) established by DFO in the Bay of Fundy in 1985. The SDDF is a hybrid venture operating

as a private sector entity established with DFO start-up contributions provided under an ERDA fisheries development program. This farm funds its own research activities by selling its harvest. The Committee notes that the financial agreement governing the operation of this farm expires in 1989. Appropriate efforts should be made to ensure the continuation of this project as well as the initiation of similar projects on the West coast. There are at present apparently no research facilities in BC which have the capability of conducting commercial scale-up and refinement of techniques developed in the earlier stages of the innovation chain.' A potential source of funding for such projects on the West coast could be the Western Economic Diversification Fund.

b) DFO's East Coast Aquiculture Research Program

The main centers of aquiculture research in Atlantic Canada are the Saint-Andrews Biological Station in New Brunswick as well the Halifax Fisheries Research Laboratory in Nova Scotia; both institutes are components of the Biological Sciences Branch of the DFO Scotia Fundy Region.

The research being carried out at the Biological Station is, as its name suggests, biologically oriented: i.e. scientists seek to obtain biological information on the life history and growth physiology of Altlantic salmon as well as other species which are candidates for the aquiculture industry. Examples of such species include lobsters, flatfish species such as halibut, molluscan shellfish such as scallops. Much of the research on lobsters while not having yet solved the problems preventing the economical farming of lobsters has however led to some important developments such as the holding of live lobsters for marketing in the off-season. An interesting research strategy followed at the Station involves emphasizing the development of knowledge on the later growth stages of halibut while other countries seek to resolve the more difficult problems related to the reproductive and early growth stages of halibut. The objective of such a strategy is to have the Canadian aquiculture industry ready to move into halibut aquiculture once the problems associated with the earlier life-stages of this species have been solved and transferred from other countries such an Norway where much more resources are devoted to aquiculture research and development especially as it relates to finding new candidate species for this activity. This strategy which is also followed in research on scallops is a good example of how DFO scientists attempt to meet the long term needs of the industry on limited budgets and resources.

The Biological Station in cooperation with the New Brunswick Department of Fisheries and Aquiculture, and DFO'S Bedford Institute of Oceanography, is conducting research on the impact of salmon culture on the marine environment. This work is focussed on providing information for site size and separation based on environmental and oceanographic conditions. The impact of toxic algal blooms on aquiculture production is also being investigated.

In 1974, the Atlantic Salmon Federation, in cooperation with the Biological Station, established a Salmon Genetics Research Program to investigate the role of selection in stock improvement. This research program is a good example of government-private sector scientific cooperation and is now developing salmon broodstock strategies for the Bay of Fundy industry. This has provided Canada with a leading edge in the field of the selection and development of improved Atlantic salmon strains for aquiculture. Factors such as increased growth rates, delayed maturation, condition factors and disease resistance all have been shown to have a strong genetic component.

The Biological Station was also responsible for the establishment of the Salmonid Demonstration and Development Farm which has proven to be a highly effective means of technology transfer of government research to the salmon aquiculture industry. Most importantly, it is located in the midst of the major growing area on the East coast. The SDDF is governed by a federal, provincial, industry committee that oversees the technical program and ensures that the trials and experiments are relevant to the needs of the Bay of Fundy industry. To date the emphasis has been on fish feed performance, broodstock development, and improvements in husbandry practices. Biological data and results from the commercial scale trials allow direct application to the industry. The overall objective of the SDDF is to develop effective grow out strategies that will reduce production costs, extend the production and continuity of supply and improve the industry's competitiveness within the international marketplace for Atlantic salmon.

There are generally on the East coast much less problems with industry perceived conflicts between short and long-term research objectives, basic and applied research, especially as it relates to the salmon farming industry. This is because the development of Atlantic salmon farming in such countries as Norway, partly based on the transfer and adaptation of past research carried out in Canada, has contributed to a much broader base of knowledge of Atlantic salmon husbandry. [n contrast, the farming of Pacific

salmon is in its initial stages and there is a much wider gap to bridge in terms of the knowledge required in the areas of husbandry, diseases, etc... However, even in the case of Atlantic salmon farming much research has yet to be carried out since technology and knowledge is not, in most cases, directly transferable even when it relates to the same species. The different environments in which salmon might ultimately be farmed in Atlantic Canada requires for example adapting diets, hence the importance of nutrition research to support the development of the industry in Canada as well as continued research in the area of fish health, two activities carried out at the Halifax Fisheries Research Laboratory albeit with limited resources.

Although the presence of the Demonstration farm and a wider distribution of DFO scientists and "aquiculture coordinators" between DFO'S various administrative regions in Atlantic Canada enables better links between the aquiculture industry and government scientists than in British Columbia, the East coast industry also wishes to have, input into the determination of 'research priorities, better extension services as well as increased allocations of resources to research activities.

Other areas of research required for the industry's stable development is evidently in the area of shellfish toxicity involving domoic acid and other toxins. This question is however dealt with in the next section which addresses some concerns specific to the molluscan shellfish aquiculture sector.

A particular aspect of the DFO'S aquiculture research activities on the East coast is the situation in the Quebec Region. Out of the more than 100 scientists working at the recently opened Institut Maurice Lamontagne, the headquarters of DFO'S Quebec Region, only 3 positions are aquiculture related. This means that the **Quebec** Region's major role will be to act as a clearing center for the transfer and extension of aquiculture research carried out in other areas of the country. It should be noted that the situation is much the same in Newfoundland where no expansion of research activities in support of aquiculture is planned. DFO'S Newfoundland Region expects to concentrate its activities in the transfer and adaptation of technologies such as those developed for the New Brunswick salmon farming industry.

The federal government should take a lead role in aquiculture research in Quebec and Newfoundland in the same way that it has done so in other provinces. It should do so in Quebec notwithstanding the particular

problems of the aquiculture industry in that province where outdated and restrictive marketing regulations constrain aquiculture development. More details on the nature of these problems are contained in the section of the report which deals with marketing issues.

c) Overview of Research and Development Requirements in Aquiculture

Fisheries research in Canada has now come full circle. Aquiculture was developed from fundamental research carried out with respect to the wild fisheries. Research in aquiculture can now contribute to wild fisheries research as advances in scientific knowledge of the reproductive and growth cycles of certain species will enable the perfecting of methods used for such activities as stock assessments and enhancement in the wild fisheries. It is counterproductive to view fisheries and aquiculture research as two separate areas of scientific activity. The problem is not that aquiculture is carried out as an adjunct to wild fisheries research but that the scientific infrastructure directed at carrying out wild fisheries research must now be adapted and expanded to respond to the needs of the aquiculture industry. This means that while basic (which in some cases also implies long-term) research must continue to be carried out, the research infrastructure must also be designed to respond to the aquiculture industry's research priorities and to respond as quickly as possible to its needs which change as the industry develops. This means implementing new mechanisms for technology transfers from government to industry, from one region of the country to the other, for the extension of technology and knowledge, and for the commercial application of fundamental research.

Aquiculture is an industry where "yields depend largely on investments, skills and technology rather than the natural productivity of the environment as for the wild fisheries".[10] This is particularly true in Canada where technologies must be developed to overcome some bio-environmental disadvantages. Aquiculture is, in Canada, a viable industry offering high rates of return on investments albeit with presently high risk levels which should diminish if the appropriate policies are put in place. The burgeoning Canadian aquiculture industry will founder if the infrastructural equipment, particularly in terms of R&D, is not put in place. Presently, the industry's infrastructural requirements are growing and the financial resources available to respond to these needs are decreasing. The least that is required is that these resources follow the same trend, if not the same actual rate, as the industry's growth rate.

6. *Molluscan Shellfish Aquiculture*

Although much of what has been said until now emphasizes the farming of salmonids as the leading edge of Canadian aquiculture industry, it applies to all sectors of the aquiculture industry. However, some specific remarks have to be made with respect to molluscan shellfish aquiculture in Canada.

a) The Oyster Farming Industry in British Columbia

Mollusc aquiculture on the BC coast is presently limited to oyster farming on some 400 leases utilizing about 1,600 acres of foreshore. This sector was responsible for the production of about *3,700* tonnes of Pacific oysters valued at $3 million dollars in 1986. Two major factors are limiting the full development of this sector in British Columbia. One of these is the limited availability of suitable tidal flats combined with the fact that in BC, provincial government policy is to allocate much of the wild oyster resource to commercial harvest. Another of these problems is the limited availability of oyster seed. However, a resourceful private company (Innovative Aquiculture Product) has established the first commercial shellfish hatchery in BC by adapting oyster hatching techniques already successfully being used in other countries such as the US, Japan and France. Another commercial oyster seed hatchery is now operating in the province in Baynes Sound and contributing to solving the seed problem. However, the industry is still largely dependant on the import of oyster seed from the United States, particularly from the State of Washington where some individual oyster companies have harvests larger than the total BC production of oysters. As well the successful development, adaption and more widespread use of off-bottom culture techniques will help resolve the problem of limited availability of suitable tidal flats as well as to better growth rates and marketability:

> If the [BC oyster farming] farming industry is to expand, a much heavier seeding program must be undertaken on existing leases and suspended culture widely adopted; good farming practices must be carried out in all culture phases. A major reason the industry has not undertaken these programs is apparently because the profit margin is too small to permit borrowing capital. [1]

One of the problems in the oyster farming industry that has been solved is that oyster leases which are administered by the province now include diligent use clauses. However, the major problem which is the availability of capital for expansion still exists although some 700 thousand

dollars in loans were recently made available to some 18 growers under the BC Aquiculture Incentive Program. The BC oyster farming industry is still functioning at the level of a cottage industry composed of a large number of small producers. It is far from realizing its full potential: while production has in recent years steadily increased to the level of 3,700 tonnes, this is still far below the industry's peak of 6,000 tonnes in 1963. As emphasized by the authors of the above quote: if a thriving oyster industry cannot be established in British Columbia, it is unlikely that any other marine invertebrates [such as mussels, clams, scallops] can be cultured economically in the province.

b) Molluscan Shellfish Aquiculture in Atlantic Canada

In Atlantic Canada, mollusc aquiculture is only slightly more diversified than on the BC coast comprising both oyster and mussel farming. Mussel culture has greatly increased in recent years. To date, the major area of production in Atlantic Canada has been PEI which, in 1986, accounted for 80 percent of the value of oysters and 60 percent of the value of mussels produced in Atlantic Canada. However, mussel culture is starting to grow in other areas as well such as Nova Scotia, New Brunswick, the Magdalen Islands in Quebec and Newfoundland.

The mollusc farming industry in Atlantic Canada has until now been exclusively based on natural or wild seed collection which has in some years been a hindrance to the industry, especially in oyster farming. A notable recent development in the industry is the setting up, in Nova Scotia, of the first commercial shellfish hatchery in Atlantic Canada. It is expected that this will eventually lead to the diversification of molluscan shellfish aquiculture into the cultivation of other species such as scallops and clams.

Much like what was the case in British Columbia, development of the industry in Atlantic Canada has been constrained by outdated regulations and policies. Examples of these include the lack of diligent use clauses in oyster leases and outdated regulations on the size of oysters that can be harvested. For example, in New Brunswick, the harvesting and marketing of oysters under 76 millimeters is prevented by a regulation which was designed to protect the resource located on public oyster beds from overharvesting. This regulation prevents the oyster growers from developing the market for small-sized oysters, something which is an increasing trend in other countries and which would shorten the lengthy growth cycle and increase the industry's profitability. Like the BC industry, the Atlantic oyster industry has financing problems related to the lengthy growth and harvest cycle (up to

five years) which results in a negative cash flow in the initial operating years. Mussel growers, unlike oyster farmers have recently received financial assistance from the federal government in the form of loans to be delivered through the Federal Business Development Bank. It would seem that, notwithstanding recent toxin problems, the demonstrated success of "Island Blue" mussel culture in PEI has resulted in generally more funds being channeled into this sector than into the modernisation of oyster culture. [t should be noted that the success of mollusc aquiculture in PEI is related to mollusc enhancement work which started in the 1970's in support of the public oyster fisheries on Prince Edward Island and to the strong federal/provincial collaboration in support of mussel culture development. Since the early 1980's, this collaboration, mainly through ERDAs, has led to a variety of improvements in culturing and harvesting technologies, processing technology and transportation methods. It is suggested that the development of mollusc aquiculture in PEI serve as a model in those provinces wishing to obtain the benefits of the development of similar industries.

A review of the Atlantic shellfish aquiculture industry cannot be considered complete without mentioning the recent problems caused by the toxicity of molluscs.

In response to the recent problems, improvements have been made to the Shellfish Monitoring Program involving enhanced monitoring of water quality levels by Environment Canada, increased monitoring of products by DFO'S Inspection Branch and increased surveillance of growing areas to prevent harvesting in closed areas. The recent events show that while improvements to monitoring, inspection and enforcement were necessary and have been undertaken, it is also necessary to allocate additional resources to the Department of Fisheries and Oceans for basic ongoing research into mollusc toxicity to obtain the scientific knowledge necessary to handling such problems in the future such as the origin of marine toxins. The most recent indications are that DFO's Gulf Region will be receiving 2 PY's and funds totalling 570,000 dollars for the establishment of a research program in this area. A similar allocation will be made to DFO'S Scotia Fundy Region where a long term research effort has been made on the prediction of the occurrence of mollusc toxicity. This, in part. will compensate the Saint Andrews Biological Station for the attrition of their marine toxin research activities prior to the recent problem. Determining the origins of the problems will hopefully lead to the knowledge required to forecast occurrences of mollusc toxicity. This, combined with better product inspection, should contribute to stopping shipments of toxic products before

they reach the markets thus protecting the consumers' health and preventing the economic disruption of the industry. These additional resources will complement some marine toxin research to be carried out at the Maurice Lamontagne Institute in DFO'S Quebec Region.

The recent events also demonstrate that there is a need for a formal review exercise of the protocols established for inter-agency cooperation in the handling of such emergency situations. An ad hoc review was carried out internally by DFO following these events but the results of this review need to be formalised to serve as the basis for the establishment of a crisis management plan backed with an emergency contingency fund to deal more effectively with future occurrences.

It is evident for example, that the whole East coast shellfish industry was seriously affected as a result of certain public statements made by poorly informed officials assigned to handle the problem. The industry was also needlessly affected by the inability of correctly assessing the toxic agent (zinc) in Caraquet oysters which proved to be toxic to mice but inoffensive to humans. This suggests that a long term commitment to a dedicated mollusc toxicity research program is needed to overcome a lack of basic knowledge in mollusc toxicity generally as well as a lack of sophistication in toxicity testing methods.

The recent problems led to a complete ban on the shipment of shellfish products from Atlantic Canada even though the problem (domoic acid in mussels) was highly localised to the Cardigan area river in Prince Edward Island. This suggests that, in the future, closures should be implemented by regional fishery officials based on monitoring and scientific advice.

In addition, emergency coordination efforts and communications should be handled directly from the region where the problem is occuring. The possibility of extending closures if the problem is found to be more widespread should be based on monitoring data and actions taken as appropriate to prevent the needless destabilization of the fishing industry.

7. *Fish Health*

This section addresses the public and/or private sector infrastructure requirements for fish and shellfish health, such as disease diagnostic and veterinary services, for the control of diseases in the aquiculture industry.

It cannot be sufficiently emphasized that the development of a viable aquiculture industry largely depends on the establishment of an adequate disease diagnostic and veterinary service with field capabilities and central laboratory facilities. This is true for all forms of aquiculture, but particularly so for the salmonid farming industry, which is highly vulnerable to diseases, as the Norwegian experience has shown. In the case of the Pacific salmon farming industry, there are particular concerns as adequate husbandry knowledge has yet to be developed and the industry is largely based on undomesticated stocks of Pacific salmon, which are highly susceptible to stress and resultant diseases.

Examples of diseases affecting salmonid species include the following. Bacterial kidney disease, which affects both wild and pen-reared stocks, is widespread on both Canadian coasts but not an important problem in areas such as Ontario where more resistant salmonid species such as trout are reared. Another major disease is vibriosis which only affects salmonids raised in sea water. Another important health problem in salmonid farming is furonculosis, a bacterial disease which is also widely distributed across Canada.[12]

Until recently, in line with the federal government's responsibilities under the Fish Health Protection Regulations, fish health services were provided on the West coast by the Pacific Biological Station. However, the capacity of PBS has now been completely surpassed due to insufficient resources. There is also an apparent lack of educational programs for the training of fish disease professionals. [13] The developing imbalance, if uncorrected, could jeopardize the industry, since it increases the risks in setting up aquiculture ventures.

In the Maritime provinces, disease diagnostic and control services have been provided by the Fish Health Unit based at the Halifax Fisheries Research Laboratory. This Unit is operated by the Biological Sciences Branch of DFO and its capabilities have been overwhelmed due to insufficient funds, personnel cutbacks and the rapid growth of the salmon industry particularly in the Bay of Fundy. Although in the long term, the East coast salmon aquiculture industry is not expected to experience the level of expansion expected on the West coast, its production presently exceeds that of the West coast.

There is no question that a fully developed aquiculture industry will eventually be able to pay for its own disease diagnostic and veterinary services. Since demand usually creates its own supply, such private sector capabilities will eventually develop if the appropriate educational programs are put in place by the responsible authorities. However, a palliative is needed in the meantime.

The Department of Fisheries and Oceans must expand its disease diagnostics and veterinary services; these services should eventually be provided on full cost-recovery basis so that this expansion does not create industry dependency on government or compete with the development of such capabilities by the private sector or by universities. Also, to encourage university involvement in fish health, as well as an increase of aquiculture and fish veterinary medicine in the curriculum, scholarships in fish health research and veterinary medicine should be established in Canadian colleges and universities. This would be particularly appropriate for such institutions as the University of British Columbia, Malaspina College and the UPEI Atlantic Veterinary College which have dedicated fish health and aquiculture programs within their curriculum.

There also remains the governmental responsibility to monitor, screen and control the distribution of seedstock before it is transferred from hatcheries to marine grow out sites. In Atlantic Canada this is especially critical in controlling salmonid diseases, such as BKD, which is vertically transmitted (*ie.* eggs from infected females are also infected) and furunculosis (where the disease exists in juvenile salmonids in a carrier state which is only detectable under specialized test conditions). These regulatory responsibilities are steadily increasing as the industry expands. It is an area of critical importance to the longterm viability of the industry.

8. ***Public Sector Infrastructure Requirements***

a) The Egg Supply in the BC Salmon Farming Industry

A major problem for the BC salmon farming industry is limited access to wild salmon eggs. Out of the 30 million chinook eggs requested by the industry in 1987, DFO was only able to provide 4.5 million eggs. This due to the strong conservation concerns for chinook stocks which are being subjected to increasing pressure and which unfortunately also happen to be the aquiculture industry's preferred species. It should be noted however that

these 4.5 million eggs, from DFO'S enhancement facilities. were made available to the aquiculture industry at subsidized prices.

The industry claims that its need for wild stock eggs is short-term only, given that it prefers the eggs of domesticated fish and is developing its own domesticated broodstock. However, the need to access "quality wild strains" is likely to remain in the medium and long-term, in order to improve domesticated broodstock and maintain hybrid vigor.

The DFO Pacific Region has stated quite clearly that in the current situation with respect to the conservation of wild chinook stocks, these stocks will not be able to supply the amounts of eggs needed for the continued growth of the aquiculture industry. Thus, the industry must develop its own broodstock. The availability of eggs will certainly turn out to be a major factor limiting entry into the salmon farming business.

A partial solution to the egg shortage could be achieved by allowing the aquiculture industry to access eggs from the Indian food fishery under controlled circumstances. This potential solution merits further study by the government.

b) Broodstock Development Programs

In New Brunswick, salmon seedstock from DFO'S Scotia Fundy Mactaquac and Saint John hatcheries, have provided a strong basis for the Bay of Fundy industry. All salmon smelts provided, in 1988 up to 200,000 fish, have been on a cost recovery basis. The Maritime policy is that commercially produced smelt must first be sold to the industry before DFO smelts are made available. A federal provincial salmon seedstock committee, which involves the Scotia Fundy and Gulf Regions, determines, in consultation with industry, the total availability of smelts, and the potential allocation from DFO sources. The Crown Assets Disposal Corporation finalizes the contracts with the growers for the DFO fish received. This DFO support to the Bay of Fundy industry has been a key factor in its success. In the future, this DFO role will change from a primary supplier of seedstock, to one of an active participant in broodstock development and conservation.

In line with its belief that the industry must develop its own broodstock to meet its forecasted egg requirements, DFO is cooperating with the industry on both coasts on broodstock development programs. In the Pacific Region, it has identified stocks which could sustain a small harvest to

provide the genetic material necessary for such a program. DFO and the BC Ministry of Agriculture and Fisheries are also cooperating on the design of this program. Similarly in New Brunswick, both levels of government and the industry have developed plans to maintain and improve the strains of Atlantic salmon (Saint John River stock) which have been demonstrated to have superior traits for aquiculture (e.g. rapid marine growth, delayed sexual maturation). In Nova Scotia, the seedstock committee coordinates the allocations of salmonid stock to the industry in that province.

c) Structural Changes to DFO's Organization

The significant economic impact of aquiculture and its rapid development in Canada justifies new funds being allocated for the establishment of a senior level service (headed by an assistant deputy minister) in Ottawa which would be clearly identified with the aquiculture industry and vested with a strong mandate for aquiculture advocacy. This service would need to have strong links with the Science Sector of DFO given its present responsibilities for fish health protection, disease and nutrition research and the strong R&D role DFO will have to assume for the continued development of this industry.

The enhanced "national centre" would also need to have strong links to augmented aquiculture divisions in regional headquarters and laboratories where the day-to-day links with the industry take place. The Committee notes that the "core" groups set up at DFO'S regional headquarters on the Pacific and Atlantic coasts to deal with the aquiculture industry were created as a result of regional decisions reallocating existing resources. These efforts, however laudable, can only be regarded as stop-gap measures which cannot be expected to meet the growing demand and requirements expected of the Department with respect to its aquiculture related responsibilities.

d) Raw Materials for Fish Feed

The salmon aquiculture industry can expect to have substantial problems obtaining the raw material for fish feeds. This is particularly true on the West coast where there are few species which can be used for such purposes. Hake, which is relatively abundant on the West coast with a total TAC of 98,000 tonnes, would be suitable for manufacturing fish meal, but, this species has been allocated to foreign countries such as Poland, Korea and Russia under agreements whereby they must buy equal amounts of fish from Canadian fishermen in over-the-side sales. The obvious solution would be

gradually to phase-out foreign fishing of this species, assuming that Canadian fishermen would economically benefit by supplying fish feed manufacturers. However, the prices obtained by Canadian fishermen through over-the-side sales are about 3 cents a pound higher than those that could be obtained by landing hake domestically. In the short-term, there is no solution in sight except that as the demand for fish meal rises, prices may rise to the point where it would become economical to land hake domestically. In the meantime, the BC industry will look to importing fish meal from Atlantic Canada or from South American countries. In Atlantic Canada, fish feed sources such as herring and capelin are more abundant. Research is already underway in the Bay of Fundy area on the utilization of roe herring carcasses for fish silage and fish feed production purposes. On the West coast, other species which could possibly serve as raw material for fish meal include anchovies, roe herring carcasses and krill, a small planktonic species of shrimp. However, the ecological implications of using new resources such as krill and anchovies for fish feed would have to be studied given their importance in the marine food chain. The Western Economic Diversification Fund could serve as a source of funding for developing such experimental fisheries.

9. ***Marketing***

A number of needs are identifiable in the area of marketing: improved intelligence, quality and continuity of supply, and generic promotion of Canadian aquiculture products. Part of the success of the Norwegian aquiculture industry is attributable to consolidated export and marketing activities and generic (industry funded) promotion. How can a similar result be achieved in Canada? Part of the answer lies in developing a Canadian aquiculture industry trade-mark and identity associated with high quality and consistent supply. To achieve this there should be strong industry associations, purchase and sales cooperatives, export consortia, etc... There are a number of programs already in place, such as PEMD (Program for Export Market Development), through which the industry can establish itself on international markets. Government leadership will presumably be required to achieve some of these objectives; however, the largest part of the responsibility lies with the industry itself.

By 1990, in less than two years, the BC farming industry expects to be producing 15,000 tonnes of product valued at nearly $120 million. ” The successful marketing of these quantities of BC farmed salmon will depend on the industry’s ability to organize its marketing activities so as to maximize its competitive advantages: the consumer’s relative preference for chinook, the

industry's ability to select and control product attributes, a consistent level of supply and quality, lower transportation costs and so on.[15] The BC Salmon Farmers Association has already realized this and is carrying out a number of activities to bring this about including the participation in international food fairs with PEMD assistance as well as the development of quality control procedures to be followed by association members.

The sales value of Atlantic salmon produced in the Bay of Fundy is projected to reach $35 million in 1988 and $60 million in 1989. The majority of the farms in that area market their product through the Atlantic Silver marketing cooperative whose name also serves as a distinctive trade-mark. Through the efforts of this cooperative, the smaller growers have achieved stable prices and the period of market sales has been extended from August to February. Initially sales of the Bay of Fundy product were Canadian; in 1987, 40 percent of the 1,300 tonnes produced was exported to the United States and this percentage is expected to increase significantly.

An area where government leadership will be most important, at least in the development stages of the industry, is in improved marketing intelligence and information. For example, in the salmon farming industry, numerous marketing studies have been carried out. Some have a very positive outlook, others conclude that the markets will be quickly saturated while others favor the optimistic but cautious approach.

From a study of the latter type, it appears that, in the US, which will initially be the Canadian salmon farming industry's major market, consumption of salmon in the fresh/frozen could potentially increase by 50% assuming the preferred salmon products were available all-year round. This seems to borne out by the rapid growth of fresh/frozen salmon consumption which occured in the United States between 1983 and 1985: consumption increased from 53,000 tonnes to 73,000 tonnes. Even with such a substantial increase, consumption per capita remains very low in the US: below 0.4 Kg/capita or less than a pound per inhabitant. A 50% increase in the consumption of fresh/frozen salmon would bring US demand to about 112,000 tonnes. The study states that the total supply of fresh/frozen from all sources (Canada, Norway, Scotland, Chile, Ireland, Washington State, etc...) is projected to be around 110,000 tonnes. About 60,000 tonnes of this amount would be wild product and the remainder, farmed product. Thus the study states that "the forecasted supply of salmon to the US market until 1990 could be absorbed at current prices, provided no supply or distribution constraints existed. In reality, average real prices for salmon will likely

continue to decline" as more efficient production methods are developed and profit margins are reduced from their presently high levels.[16] However, the downward or upward pressure of supply problems on real prices must not be underestimated, the wild fisheries (which can be expected to continue to account for a very large part of the supply) are subjected to substantial cyclical variations and the farming industry, in Canada and even in Norway, is still not in a position to supply the markets on a year-round basis.

The above suggests that, in the salmon farming industry, optimism is warranted but caution is needed. In furthering the development of the Canadian industry, the government should closely monitor its development in relation to changes in marketing conditions. In Scotland, much attention was paid to this by requiring that potential aquaculturists, applying for government financial assistance identify the markets they expected to be serving. Once applicants began talking about markets already serviced by the industry such as the UK and EEC, government assistance levels were substantially decreased although assistance continued for those wishing to develop the yet to be fully exploited US market.

On the subject of marketing, it is important to note the ambiguous attitude prevailing towards aquiculture development at the provincial level in Quebec. Although the Quebec Ministry of Agriculture, Fisheries and Food (MAPAC) is a strong backer of aquiculture development, the Quebec Ministry of Recreation, Hunting and Fishing enforces regulations preventing the sale of slaughtered salmonid and some freshwater game species which are important candidates for the aquiculture industry. These species can, however, be sold live for enhancement purposes and much of the present Quebec aquiculture industry is geared towards the enhancement of the recreational fisheries. These regulations, initially designed to prevent the fishing of game species for commercial purposes are now preventing the development of aquiculture in Quebec and jeopardizing substantial investment projects. Notwithstanding these regulations, it is interesting to note that the commercial demand existing in Quebec for some anadronous and freshwater game species (such as arctic char, trout, sauger, etc...) is supplied by the Freshwater Fish Marketing Corporation located in Manitoba. It should be pointed out as well that the limited availability of such species from the freshwater commercial fisheries in Ontario and the Prairie provinces offer opportunities for aquiculture development in these areas.

As a result, the aquiculture industry in Quebec could miss the window of opportunity offered by the farming of salmon and some highly

prized anadromous and freshwater species. The **Quebec** industry seems to be more advanced in land-based technology than in other areas of the country. Some Quebec producers seem convinced that this technology which helps them overcome unfavorable climactic conditions is cost effective and competitive.

CONCLUSION

Aquiculture is not a new endeavour in Canada. There were salmonid hatcheries operating in Canada as far back as the late 1800's and by the 1920's, there was a large network of federal hatcheries put in place across Canada for a number of species including salmon, trout as well as lobsters. Notwithstanding this, aquiculture today in Canada is still in the take-off stage struggling with some rather serious problems. There are of course some small but more developed sectors such as trout farming in the Prairie Provinces and in Central Canada, however the promise of benefits from aquiculture development remains largely unfulfilled in relation to its full potential.

Aquiculture is a high risk and knowledge intensive industry. The benefits such as employment, income, investments and exports that can be derived from the industry's development are however directly proportional to the level of risk this industry entails. Although the Committee notes that while the level of federal government support for the development of this industry is growing, the commitment to this support is still largely uncertain and is being delivered in a piecemeal fashion through a variety of mechanisms. Not the least of the reasons explaining this is the inability of the provincial and federal levels of government to coordinate their support of the industry. Although some progress has been made in this area, much remains to be done.

Some people will state that a "grand design" is required for the aquiculture industry. Others will state that this is unlikely to help given the mosaic of regions and aquiculture species encompassed by the industry. Although a "grand design" is difficult to elaborate and implement on a national scale, it must be attempted. Such a task will be easier if, in a prior exercise, provincial plans are prepared. The federal and provincial governments cannot hope to achieve productive working relationships and a satisfactory delimitation of their respective areas of competence if they have not, in a prior exercise, determined in rather specific terms what objectives are to be achieved. Once these objectives, which can include production and job creation targets on a sectoral and geographical basis, are established, each level of government can best determine how it can contribute to the achievement of these objectives.

Financial assistance provided to the industry has slowly increased. However, the industry's financial requirements are being addressed in a

piecemeal fashion often through programs which are ill-designed relative to its rather specific requirements. The option of consolidating the various means of financial assistance presently available to the industry under a single program must be seriously considered along with an increase in the financial resources presently being made available to the industry. The least that should be done is to tailor existing programs so that they better reflect the needs of the industry. There is no question that the financial assistance provided to industry will result in high cost-benefit ratios given the rates of return that seem to occur once an aquiculture business has overcome the negative cash flow problem of the first few years, particularly in salmonid aquiculture. However, the financing problems are presently such in the industry that Canada cannot expect to have a viable aquiculture industry without some amount of seed money being provided for the development of the newer sectors of the industry and for the modernization and expansion of the older sectors such as the oyster industry. There have been some interesting results from projects put in place through fisheries development agreements in various areas of the country such as New Brunswick and PEI, however, such projects need to become more widespread.

From the point of view of infrastructural requirements, there are a number of gaps that have to be filled temporarily by governments in the area of fish health and diagnostic services, possibly even in the area of hatcheries and broodstock development programs, etc. If such services are partially provided in the medium-term on a cost-recovery basis, the private sector will eventually fill the void. However, the most important type of infrastructural support needed is "soft" infrastructure: i.e. research and development. The industry has specific priorities in this area which must be addressed by government to facilitate its development. However, government research must also address long-term issues, the more traditional role of governmental research. Also, the best way of ensuring that increased R&D efforts pay off is to ensure that there exist mechanisms of extending this research into the commercial application phase as well as mechanisms for the adequate dissemination of scientific information, something which does not seem to be the case presently.

Another essential element for aquiculture development is the development of a comprehensive and rational regulatory framework for the industry. Some sectors are operating without any type of regulation while other sectors are hampered by the inappropriate application of fisheries regulation to their operations. The provision of a "master" legislative framework through the adoption of a national aquiculture statute should be seriously considered by the federal government. The regulatory frameworks

specific to the various sectors could be addressed by regulations under the authority of such a statute.

Whatever is decided with respect to the adoption of a national aquiculture statute, it will also be absolutely essential that the federal government affirm its commitment to developing an aquiculture industry in Canada as well as reaffirm its commitment to maintaining the wild fish stocks. This implies expanding the activities of the Department of Fisheries and Oceans and requiring it to take a proactive stance as the lead federal agency for the aquiculture industry.

Recommendation 1

That the Department of Fisheries and Oceans fulfill the national responsibilities for aquiculture development in Canada and recognize that the needs of the aquiculture industry are different from those of the present fishing industry. Aquiculture, being a production based industry, requires its own specialized regulations, services, research and development programs in such areas as product inspection, fish health, biological and environmental research. These needs must however not be met at the expense of programs serving the existing fishing industry. This should be accomplished by:

(a) the establishment of a National Interdepartmental Committee on Aquiculture, chaired by DFO, with the mandate to develop a comprehensive national aquiculture development plan. This would be based on provincial plans prepared by the Aquiculture Coordinating Committees. These plans should include objectives such as environmental protection, production, investment and job creation levels per species sector of the industry as well as the requirements for their achievement.

(b) a study of the provincial and federal regulatory requirements needed for the orderly development of the aquiculture industry in Canada. This study, to be carried out by the Department of Fisheries and Oceans, should also include the identification of the regulations hindering the industry's development.

(c) a resolution of the outstanding issues which have stalled the completion of the Aquiculture MOUS such as in British Columbia and the development of federal regulations in Nova Scotia. However, the resolution of these issues must not in any way compromise the protection of the wild stocks, their habitat and the environment. As well the federal government should work to clarify the situation in Quebec where an agreement has been signed but its implementation is impeded by the problems particular to that province.

(d) an acceleration in the development, by the Department of Fisheries and Oceans, of a national system for the collation and presentation of statistics on Canadian aquiculture production and markets. A first report, containing a historical perspective on the industry as well as the most up-to-date statistics, should be

published in 1988. These statistical reports should include input from all the provinces and territories of Canada.

(e) the creation of a senior level service (head by an Assistant deputy minister) at departmental headquarters to serve as the coordinative focus for all aquiculture activities particularly those taking place within the Science Sector. Parallel to this should be the creation of regional aquiculture divisions in DFO'S Regions and laboratories where the day to day links with industry take place.

(f) up-dating environmental regulations so that they take into account the potential impact of the aquiculture industry on the environment.

Recommendation 2

That DFO appoint representatives of the Canadian aquiculture industry as members of the Fisheries and Oceans Research Advisory Council (FORAC). As well, an aquiculture advisory committee should be created to advise the Minister on questions pertaining to the aquiculture industry.

Recommendation 3

That one of the following policy options be adopted to consolidate the federal regulatory instruments which pertain directly to the aquiculture industry:

(a) The introduction of a National Aquiculture Act which would be the enabling authority for the development of a consolidated and comprehensive body of federal regulation, which would be administered by DFO and apply to the aquiculture industry across Canada.

(b) The consolidation, modification and improvement of the various acts, regulations and guidelines that pertain to aquiculture development, with particular attention focussed on the Fisheries Act.

Recommendation 4

That the federal government make legislative provisions which would allow citizens to petition DFO to fulfill its mandate for the protection of fish habitat and the preservation of wild stocks.

Recommendation 5

That the aquiculture industry participate fully in all the provincial Aquiculture Coordinating Committees established under the MOUs. This implies industry membership for direct input into the preparation of development plans, the establishment of governmental research priorities, the identification of infra-structural requirements and the development of the regulatory framework applying to aquiculture.

Recommendation 6

That the DFO review its aquiculture research and development activities and, if necessary, reorient them to ensure that they generate scientific knowledge of direct relevance to the aquiculture industry and that the mechanisms for responding to priority concerns are in place. Given the high science and technology basis of the industry, new funds must be made available to increase R&D efforts in the following areas:

(a) research in support of regulatory requirements:

- disease diagnosis, prevention and control,
- impact of aquiculture on fish habitat, traditional fisheries, water quality,
- residues in aquiculture products with the objective of assessing their potential effects on human health and that of marine organisms,
- fish feed composition,

(b) problem solving, applied research in response to industry concerns.

(c) research on the biology of new candidate species

(d) on genetics and biotechnology.

Recommendation 7

That DFO make research extension staff available to facilitate the transfer of scientific knowledge from its R&D programs and provide technical support to the industry on location. In addition, selected field Fishery Officers must be trained in aquiculture to increase their knowledge of the needs of this new industry. This will allow them to improve their understanding of this new industry and their related obligations as field representatives of the lead federal aquiculture agency. In order to meet this objective, the Fishery Officers Program will have to be expanded.

Recommendation 8

(a) That DFO expand its fish health disease diagnostic services to meets its regulatory obligations under the Fish Health Protection Regulations in response to the rapidly developing aquiculture industry and to address the concerns of the traditional fisheries

(b) That disease diagnostic services and veterinary advice continue to be provided to the industry but on a full cost-recovery basis so that the provision of such services does not impede the development of such capabilities within the private sector.

(c) That, based on realistic targets of the numbe, of fish veterinarians needed, scholarships in fish health and veterinary medecine be established in Canadian universities with the potential of developing significant links with the industry due to their location or their prior involvement with the aquiculture and fishing industries.

Recommendation 9

That a working group composed of Revenue Canada officials, DFO scientists and industry representatives be struck to establish guidelines as to what constitutes research and development carried out by aquiculture firms to reduce the difficulties experienced by the industry in benefiting from the R&D Tax Credit. These difficulties are not uncommon in an industry which is developing new production processes and can therefore be said to be engaged in R&D on an on-going basis.

Recommendation 10

The Committee strongly endorses the concept of establishing aquiculture demonstration and development farms where experiments of commercial scale can be conducted and the results transfered to industry. For example, a farm to address the specific requirements for the marine culture of Pacific salmon should be strategically located where there is a concentration of industry activity. This should be a joint public and private sector venture with producer organizations serving as the industry's representatives. In the future, a similar approach should be developed on both coasts to support the development of molluscan shellfish aquiculture. Funding for such projects should not come from existing fisheries programs.

Recommendation 11

That additional funding be made available with a view to increase the emphasis being placed on the shellfish aquiculture industry in the conduct of DFO's aquiculture research programs, particularly with respect to the development and modernisation of the mollusc industry. Also, the development of secondary processing activities in this industry should be emphasized.

Recommendation 12

That the federal agencies involved in dealing with the recent mollusc toxicity problems conduct a formal review of the protocols established for handling such emergency situations. The results of this review should serve as the basis for the establishment of a crisis management plan backed with an emergency contingency fund for handling future occurrences. The recent increase in resources made available for research into mollusc toxicity be part of a long-term commitment by DFO to a dedicated mollusc toxicity research and monitoring program.

Recommendation 13

Given the industry's need for capital (especially working capital), the substantial difficulties experienced by the industry in meeting these requirements from domestic sources, and the need to maintain a substantial level of Canadian ownership in this industry, the Committee recommends the following:

(a) In view of the lack of information and data on the level of foreign ownership and industry concentration in the Canadian aquiculture industry, the federal government should carry out a study of these questions which would serve as the basis for future government policy decisions on the development of the industry.

(b) That a task force composed of representatives of the federal and provincial governments as well as representatives of the banking and aquiculture industries be established with the mandate to study the industry's capital needs. It should also, as quickly as possible, recommend ways of meeting these requirements and alleviating the industry's present financing difficulties, including the design of an appropriate loan guarantee program.

(c) The Committee recommends the creation of a totally new program to be identified as the "Aquiculture Development Fund". Appropriations should be authorized for the creation of such a fund which would be used to provide the industry with seed money in the form of grants and contributions. As well the fund would be used to provide loans guarantees for capital and working capital loans contracted by aquaculturalists with private financial institutions. Another possible use for such a fund would be to contract out research projects to further the development of the industry as well as provide scholarships in aquiculture studies. To ensure that aquiculture makes a significant contribution to regional development, the fund should be administered jointly by the Departments of Fisheries and Oceans and the new Regional economic development agencies on the basis of the criteria used in the Industrial and Regional Development Program. The levels of assistance provided by the fund should be proportional to an area's need for economic development activities.

(d) In addition, the Committee recommends that the existing programs already available to the industry such as the Federal Business Development Bank's programs, ERDAs, the Western Economic Diversification Fund, the Atlantic Canada Opportunities Agency, etc... be tailored to meet the specific requirements of this new industry. In this respect, the Committee also recommends that a working group composed of officials from the Department of Fisheries and Oceans and the various federal economic development agencies be struck to elaborate

ways of improving DFO'S input (as the lead federal aquiculture agency) into the selection of aquiculture projects to be funded through these programs. This is to prevent the funding of technically, environmentally and/or economically unsound projects which would be detrimental to maintaining a favorable investment climate.

Recommendation 14

(a) That scholarships and funding programs be established to stimulate the participation of Native people in this growing industry. The federal government must also continue to strive to remove the impediments identified as preventing their involvement in salmon aquiculture.

(b) Since many aquiculture sites in BC are in areas subject to aboriginal claims, the committee recommends that the federal government involve representatives of Fisheries and Oceans, Indian and Northern Affairs, the BC provincial government and the Indian bands with coastal claims in the establishment of fair site selection procedures.

Recommendation 15

That the federal government, in cooperation with all industrial sectors involved in producing salmonid species for the consumer markets, develop labelling standards.

Recommendation 16

That the Department of Fisheries and Oceans be allocated the additional financial resources and manpower necessary to implement the recommendations of this report and to carry out the activities expected of it as the lead federal aquiculture agency.

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APPENDIX "A"

CANADIAN TRIP ON AQUACULTURE

List of Organizations and people visited:

BRITISH COLUMBIA

(DFO Pacific Region)

INDUSTRY Representatives

B. Baden	- President, Aquiculture Association of B. C.;
P. McLelland	- President, B.C. Oyster Growers Association;
P. Moore	- President, B.C. Salmon Farmers' Association;
R. Nelles	- Executive Director, B.C. Salmon Farmers' Association;
T. May	- Chairman, Canadian Aquiculture Producers' Council:
B. Lehmann	- President, Western Trout Growers Association;
A. Droppo	- Canadian Bankers Association;
A. Ismond	- Chairman, Canadian Aquiculture Suppliers Association;
J. MacInerny	- Bamfield Marine Station.

GOVERNMENT - Federal

P.S. Chamut	- Regional Director-General, Pacific Region;
F.E.A. Wood	- Director, Program Planning and Economics Branch:
J.C. Davis	- Regional Director of Science, Pacific Region;
H.F. Swan	- Director, Resource Enhancement Branch;
A. Gibson	- Chief, Conservation and Protection Division;
S. Law	- A/Director, Inspection and Special Services Branch;
R. Ginetz	- Chief, Aquiculture Division.

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GOVERNMENT - Provincial

Hon. J. Savage	- Minister of Agriculture and Fisheries;
B.A. Hackett	- A/Deputy Minister, Ministry of Agriculture and Fisheries;
J.D. Anderson	- A/Director, Aquiculture and Commercial Fisheries Branch;
J. Fralick	- Manager, Aquiculture Industry Development;
H. Smart	- Research Officer, Aquiculture and Commercial Fisheries Branch;
H. Eddy	- Constitutional Lawyer, Ministry of Attorney General;
E. Denhoff	- Assistant Deputy Minister, Native Affairs;
J.P. Setter	- Acting Director, Resource Management, Native Affairs;
E.D. Anthony	- Assistant Deputy Minister, Ministry of Environment and Parks;
G.A. Roberts	- Director, Lands Policy Branch, Forests and Lands;
P. Miranda	- Office of Premier, Intergovernmental Affairs.

RESEARCH INSTITUTIONS

Pacific Biological Station

R.J. Beamish	- Director; Biological Sciences Branch, Pacific Region
Z. Kabata	- Research Scientist, Parasitology;
S. McFarlane	- Section Head, Groundfish;
N. Bourne	- Research Scientist, Shellfish;
C. Clarke	- Research Scientist, Mariculture;
R. Withler	- Genetics Research;

West Vancouver Laboratory

J.C. Davis	- Regional Director of Science, Pacific Region;

E. Donaldson	- Head, Fish Culture Research;
D. Higgs	- Research Scientist, Fish Nutrition:
C. Levings	- Research Scientist, Habitat.

B.C. Research

J. Mueller	- Director, Applied Biology Division;
D. MacLay	- A/Head, Aquiculture;
B. Burton	- Fisheries Veterinarian.

Malaspina College (Aquiculture Extension Program)

David Lane	- Director
Eunice Lam	- Instructor

NEWFOUNDLAND
(DFO Newfoundland and Gulf Regions)

INDUSTRY Representatives

Pat Dabinett	- President, Newfoundland Aquiculture Association;
David Walsh	- Atlantic Ocean Farms;
Cabot Martin	- Sea Forest Plantation Co. Ltd.;
Arnold Sutterlin	- Bay d'Espoir Salmon Hatchery Ltd.;
Len Lahey	- Rainbow Trout Farms Ltd.;
Clyde Collier	- Southern Venture Ltd.;
John Keeley	- Bay D'Espoir Salmon Growers Ltd.;
Peter Parsons	- Green Bay/Baie Verte Development;
Terry Mills	- Thimble Cove Farms;
Greg Power	- Super Sweet Feeds,

GOVERNMENT - Federal

Larry Coady	- A/Regional Director of Science, Newfoundland Region;
David Dyer	- Atlantic Canada Opportunities Agency; Business Development Consultant;

John Pippy	- Head, Freshwater and Anadromous Fish Division;
Vern Pepper	- Senior Enhancement Biologist;
Randy Penney	- Aquiculture Coordinator;
Jerry Pratt	- Head, Enhancement and Aquiculture;
Larry Yetman	- Fisheries Development Officer;
Gordon Snow	- Chief, Development Division;
Derek Shaw	- Research Scientist, Fish Health;
Lionel Rowe	- DFO; Chief Licensing;
John Morris	- Canada Employment and Immigration Commission.

RESEARCH INSTITUTIONS

College of Fisheries and Marine Technology

Chris Campbell	- Vice-President, Fisheries and Applied Marine Technology;

Marine Sciences Research Laboratory

Joe Brown	- Fish Culture Research.

NOVA SCOTIA

(DFO Scotia-Fundy and Gulf Regions)

INDUSTRY Representatives

Peter Darnell	- President, Aquiculture Association of Nova Scotia;
Paul Budrewski	- Little Harbour Fisheries;
Karen Westhaver	- Ocean Farmers Ltd.;
Louis Deveau	- Acadia Seaplants Ltd.;
Ross Bennett	- Nova Aqua Ltd.;
Brian Ives	- IMA Aquatic;
Andre Mallet	- Aquiculture Institute of Nova Scotia;
Andy Schnare	- S.F.T. Ventures.

GOVERNMENT - Federal

J.-E. Haché	- Regional Director-General, Scotia Fundy Region
J. Melanson	- Director, Inspection;
G. Turner	- Aquiculture Co-ordinator (Operations);
S. McPhee	- Regional Director of Science;
D.J. Scarratt	- Head, Disease and Nutrition Section;
R. Addison	- Research Scientist, Marine Chemistry;
J. Ritter	- Head, Fish Culture Section;
R. Drinnan	- Aquiculture Co-ordinator (Science);
L. Burke	- Director. Economics Branch.

GOVERNMENT - Provincial

Hon. John Leefe	- Minister of Fisheries;
D.A. McLean	- Deputy Minister;
L. McLeod	- Director, Aquiculture and Inland Fisheries.

PRINCE EDWARD ISLAND
(DFO Gulf Region)

INDUSTRY Representatives

Andrew Forsyth	- President, Trout Growers Association;
Eddie Murphy	- Trout Growers Association;
George Vessey	- President, Mussel Growers Association;
Greg Keith	- Vice-President, Mussel Growers Association;
David Cole	- Secretary-Treasurer, Mussel Growers Association;
William Warren	- President, P.E. I. Shellfish Association;
Vernon Denis Jr.	- President, Queens Co..

GOVERNMENT - Federal

E. Niles	- Regional Director-General, Gulf Region;
B. Johnston	- Area Manager; PEI;

M.I. Campbell	- Fish Health Biologist;
J. Worms	- Section Head Shellfish Sciences;
M. Mallet	- Aquiculture Coordinator;
J. Jenkins	- Chief, Resources Allocation PEI Area Office.

GOVERNMENT - Provincial

Hon. R. Johnny Young	Minister of Fisheries;
H.D. Doug Johnston	Deputy Minister of Fisheries;
W. Irwin Judson	Manager, Aquiculture Division.

RESEARCH INSTITUTION

Atlantic Veterinary College

Gerry Johnson	Director;
Paul Lyons	P.E.I. Veterinary College.

NEW BRUNSWICK

(DFO Scotia-Fundy and Gulf Regions)

INDUSTRY Representatives (South West, N.B. - Scotia Fundy Region)

J. Malloch	President, N.B. Salmon Growers Association;
G. Matheson	Vice President, N.B. Salmon Growers Association;
A. Pendleton	President, Atlantic Silver Ltd.;
J.M. Anderson	Vice President, Atlantic Salmon Federation;
B. Rogers	General Manager, Sea Farm Ltd.;
C. Frantsi	Manager, Aquiculture Division, Connors Brothers Ltd.;
G. Tatton	Principal, N.B. Community College, St. Andrews;
R. South	Director, Huntsman Marine Science Centre;
B. Bacon	Head, Aquiculture and Fisheries Division, N.B. Research and Productivity Council, Fredericton, N.B.

INDUSTRY Representatives (North East N.B. - Gulf Region)

Maurice Daigle	- Association Mytilicole de l'Est du N.-B,;
Gaétan Dugas	- Fédération Ostréicole Du Nerd-Est du N.-B.;
Yvon Chiasson	- Fédération Ostréicole du Nerd-Est du N.-B.;
Serge Duguas	- Caraquet Aquiculture Ltée;
Ronald Manuel	- Cooperative des Pêcheurs de Baie Sainte-Anne;
Robert Rioux	- Centre Marin de Shippagan;
Andrew Boghen	- University de Moncton, Dept. de Biologic;
Allain Bourgouin	- Université de Moncton, Dept. de Biologic.

GOVERNMENT - Federal

E.J. Niles	- Regional Director-General, Gulf Region;
N. Dugas	- Area Manager;
M. Mallet	- Aquiculture Coordinator;
J. Worms	- Shellfish Scientist;
D.J. Scarratt	- Representing J.E. Haché, RDG, Scotia Fundy Region.

GOVERNMENT - Provincial

Hon. Douglas Young	- Minister, Fisheries and Aquiculture, N. B.;
Sylvester McLauglin	- Deputy Minister, Fisheries and Aquiculture, N. B.;
David McMinn	- ADM Fisheries and Aquiculture N. B.;
Henri Légaré	- ADM Fisheries and Aquiculture N.B.

RESEARCH INSTITUTIONS - (Scotia Fundy Region)

Salmonid Demonstration and Development Farm

E.B. Henderson	- Manager;

Salmon Genetics Research Program - Atlantic Salmon Federation/DFO

J.M. Anderson	- Vice-President, Operations;

Gerry Friars	- Chief Scientist, Salmon Genetics Research Program.

DFO Mactaquac, Fish Culture Station

J. McAskill	- Manager;

DFO Biological Station, St. Andrews, N.B.

Robert H. Cook	- Director;
Jim Dustin	- Research Scientist, Salmon aquiculture;
Richard Peterson	- Research Scientist, Marine Fish Aquiculture;
Ken Waiwood	- Research Scientist, Marine Fish Aquaculture;
David Aiken	- Research Scientist, Shellfish Aquiculture;
Jennifer Martin	- Biologist, Marine Toxins.

QUEBEC

(DFO Quebec Region)

INDUSTRY Representatives

Florient Bélanger	- Syndicat des pisciculteurs;
Mario Cyr	- Association des mytiliculteurs madelinots;
Sylvain St-Gelais	- Aquiculture Manicouagan Saguenay inc.;
Marc Gagnon	- Biorex Groupe Conseil Inc.;
Lars Hansen	- Président, Association canadienne de I'Aquiculture.

GOVERNMENT - Federal

Jean Boulva	- Directeur régional des sciences, Institut Maurice Lamontage, Mont JoIi;
Richard Bailey	- Coordinateur, Aquaculture, Division de la recherche sur les pêches, Ministère des Pêches et Océans;
Jean Lapointe	- Chef, Division du développement Ministère des Pêches et Océans.

OTTAWA

From the Canadian Aquiculture Producers Council:

Tom May	- President, British Columbia;
John Holder	- Newfoundland;
Wayne van Toever	- Prince Edward Island;
Gordon Cole	- Ontario;
Garth Hopkins	- British Columbia;
Richard Moccia	- Ontario.

From the Department of Fisheries and Oceans:

Barry Muir	Director-General, Fisheries Biological Sciences Directorate;
Paul MacNeil	Acting Director-General, Strategic Policy and Planning Directorate;
Ian Pritchard	Director, Aquiculture and Resource Development Branch, Science;
Robert H. Cook	Director, St. Andrews Biological Station;
Yves Tournois	Acting Director, Atlantic Fisheries Development Branch;
Bertrand Menoury	Acting Director, Legal Services;
Ray Gallant	Chief, Development Division, Gulf Region;
Ron Ginetz	Chief, Aquiculture Division, Fisheries Branch, Pacific Region;
John Castell	Research scientist; Nutrition, Scotia-Fundy Region and Vice-President, World Aquiculture Society;
Louise Côté	international Directorate Officer;
Colin McPherson	Strategic Planning Officer.

From the Department of Regional Industrial Expansion:

Bryson Guptill	- Manager, Fisheries Products Division.

From the Department of External Affairs:

Ingrid Hall - Director, Western Europe Division;

Martial Page - Fisheries and Fish Products Division.

From the United Fishermen and Allied Workers' Union:

Jim Cameron - Member.

From the T. Buck Suzuki Foundation:

Geoff Meggs - Secretary.

"APPENDIX B"

REPORT TO THE HOUSE

Thursday, December 17, 1987

The Standing Committee on Fisheries and Oceans has the honour to present its

THIRD REPORT

Trip Report on Aquiculture

In accordance with its permanent mandate under Standing Order 96(2), your Committee travelled to Norway and Scotland from 27 October to 6 November 1987, to examine the advances made by these two countries in the aquiculture sector.

Your Committee wishes to express its gratitude for the hospitality it enjoyed in both Norway and Scotland and for the wil ingness of their hosts to share their expertise.

In this first report, your Committee puts forward its findings from the trip. Your Committee has agreed to present at a later date a second report on the subject, which will deal primarily with aquiculture in Canada.

NORWEGIAN AQUACULTURE MEETINGS

I—DIRECTORATE OF FISHERIES, AQUACULTURE DIVISION: (BERGEN)

A. Description of Directorate

The Directorate is a regulatory and advisory agency reporting to the Ministry of Fisheries, a much smaller organization, which in turn reports to the Minister of Fisheries. The Directorate is the main agency responsible for the elaboration, application and enforcement of fisheries and aquaculture regulations. The current thrust of aquiculture regulations in Norway is based on the 1985 *Fish Breeding Act.* Additional aquiculture regulations which come forth from the Directorate are based on policy directions originating in the Ministry of Fisheries, which also determines the final content of the regulations.

The Directorate consists of an administrative branch and two research institutes employing a total of about 1,000 people reporting to the Director General of Fisheries. About 220 employees work in the Directorate's Administrative Branch located in Bergen. This Branch is subdivided into a number of departments: Administration, Legal Affairs, Economics, Quality Control and Technology. Another 400 employees directly employed by the Directorate work in various regional offices along the Norwegian coastline.

The Aquiculture Division is a sub-division of the Legal Affairs Department of the Directorate. Its primary responsibility is the licensing of aquiculture operations. The Aquaculture Division is also involved in management research as opposed to the types of scientific research described below.

The Directorate's two research institutes are the Institute of Nutrition, with a staff of about 40 people engaged in nutrition studies, and the Institute for Marine Research, which employs 350 people. The latter Institute has links with 100 scientists in four universities with various marine research programs covering environmental, resource (stock management advice) and aquiculture issues. Historically, much of the Institute's activity was related to cod enhancement, but as aquiculture became a more important part of the Norwegian fishing industry, an aquiculture division was established. The Institute has on-going research programs on salmon and trout aquiculture, but more recently research has dealt with developing cod and halibut farming. In 1983, researchers succeeded in hatching cod fry, of which 50 to 70% reached the smelt stage. In 1985, 120,000 cod fry were produced. In 1986, 1,000 halibut larvae had reached the stage of eating algae and were demonstrating good growth. The main problem with halibut rearing is how to get the larvae to the stage where they can be given solid feed. The Directorate expects halibut aquiculture to be fully on stream by 1995.

B. Discussions on Aquiculture Held at the Directorate

Icing conditions do not represent a problem for the large part of the Norwegian aquiculture industry, with the exception of some areas, such as the southeastern and uppermost Norwegian coasts.

In sea-based operations, experiments are being carried out using canvas covers and pumping systems which circulate the warmer waters from the lower levels of the water column to the top layers. Land-based operations can

also be used as a solution to this problem. Along the Skagerrak coastline, three or four land-based operations will be coming on stream. While no hard data are yet available on the economics of these, it is known that they have higher capital and operating costs than sea-based operations and therefore present a larger financial risk. However, land-based operations seem to offer better control over disease and this reduces the risk factor. It is possible that land-based operations will be an option for the higher-priced species (eg. halibut) as revenues will increase in relation to operating costs. However, land-based operations are generally not thought to be a satisfactory option even for the relatively high-priced salmon.

The potential of cod farming was discussed. It appears that the major factor affecting the future culture of cod is its relatively low price. Although this fish is relatively easy to cultivate, cod farming is not viewed very optimistically in Norway. The current market price for cod is in the order of $4 to $5/kilo; the landed price of cod in the commercial fishery is about $2/kilo and this is the price with which potential cod farmers will have to compete. The first two shipments of farmed cod, totalling 50 tonnes, were sold at a negotiated price of $5/kilo in 1987. Because of the importance of the commercial cod fishery in Norway, Norwegian fisheries authorities expect inter-industry conflicts if cod farming develops substantially.

While there were initially very few conflicts generated by the growth of salmon aquiculture, the industry's continued expansion is now giving rise to some. In part, these are internal, due to the increasing competition among farmers for the best available space. While there is still room for expansion, most of the better sites are generally occupied. Current regulations stipulate that a minimum distance of 1 km must be maintained between fish farms; the minimum distance is 3 km in British Columbia. These regulations seem to have been established on a trial and error basis.

With respect to intra-industry conflicts, it is interesting to note that the Norwegians are concerned about the lack of a legal framework enabling one farmer to seek redress for damages caused by another farmer, such as excessive pollution of the environment, the transfer of diseases and other negative production externalities.

The development of the Norwegian aquiculture industry did not give rise to conflicts between fishermen and fish farmers. The Norwegian commercial salmon fishery was very small when aquiculture started to expand. In addition, the two industries were not competing for the same

markets. The landings from the commercial fishery are marketed domestically while the aquiculture industry services the export trade. Further, there were no fishermen in Norway who derived their living exclusively from salmon fishing, which was always carried out in conjunction with the harvesting of other species (mainly herring) or with totally different activities, such as land farming. The commercial salmon fishery will be phased out completely in *1988* thus leaving the use of the resource to recreational fishermen. The harvesting levels of the commercial salmon fishery (in seawater only) are currently only about 1,500 to 2,000 tonnes. The total Norwegian domestic market for salmon is about 5,000 tonnes.

Many owners and workers involved in the aquiculture industry were previously involved in the commercial herring fishery which at one point collapsed. Though there were no programs specifically designed to move people from one industry to the other, this inter-industry migration was presumably facilitated by various subsidies and grants which lowered the cost of entering the aquiculture industry, at least in its initial phases. Direct employment in the Norwegian aquiculture industry totals about 4,000 jobs and it is estimated that there is a one to one relationship between this direct employment and employment in related aquiculture service industries such as feed and equipment manufacturing. As a measure of comparison, total employment in the commercial fishery is between 30,000 and 35,000.

The comparative costs of producing salmon in Canada and Norway were discussed. Comparative data available to the Norwegians show that the most striking differences are our lower smelt costs and lower transportation costs to the U.S. markets. Other costs are apparently equivalent, although one would think that Canadian wages and possibly feed costs would also be lower. From the discussion, it also appears that shellfish is much cheaper to produce in Canada than in Norway.

The Norwegian authorities are considering implementing new regulations for the management of fish farms to prevent contamination from pollution and diseases. It has been noted that diseases are most prevalent in farms which have been in operation for 10 to 15 years. Presumably, density of farms would be a factor in these areas as regulations relating to the minimum distance between farms were not initially very restrictive. The pollution and related disease problems now apparent in Norway seem to show that the farmer's vested interest in producing healthy fish is not necessarily a strong enough incentive for him to maintain a pollution-free environment.

II—FARM SITE VISITS

A. Visit of the MO WI Hatchery and Sea Cage Sites

The Committee visited the MOWI salmon hatchery near Bergen. This land-based site provides most of the smelts for nearby MOWI sea cage operations and has an annual production capacity of a million smolts. Gravity-fed water maintains the temperature necessary to produce a constant smelt supply. The fish are graded as parrs and prior to sale (or transfer to sea cages). Smelt production which is surplus to MOWI needs is sold to other growers. The hatchery site also maintains its own broodstock and has hatching and incubator facilities.

The MOWI sea cage site is a state-of-the-art facility. It is perhaps the most up-to-date traditional sea cage installation in existence for Atlantic salmon. It has 36,000 m*su3*xx of grow-out space; this is in excess of the standard size (8,000 m*su3*xx) because the farm was established prior to the promulgation of the regulations. Not all cages were in use during the committee's visit since the site was only officially opened in September 1987.

A two-storey service centre and wharf facility are used primarily for feed storage and distribution. The bulk handling of feeds is by hydraulic cranes and self-propelled forklifts and carts.

The sea cage structure is galvanized metal supported by a variable buoyancy float system. A wide central corridor, with 12 cages on each side, is attached to each side of the central services area. The cages are single-netted as there is no threat of seal predation.

Feeding is by automatic feeders; a computer in the services building monitors environmental parameters and cage-specific dietary allocations.

B. Visit to Sea Farm AIS Marine Fish Production Unit and Research Facilities

Sea Farm A/S is one of the major salmon aquiculture companies in Norway. Founded in 1972, the company soon specialized in the production of salmon smelts. Several tank farms and freshwater cage sites for smelt production are the basis of the largest smelt production in Norway. Sea Farm A/S also has involvement in salmon marine grow-out sites and consistently

produces one-year smelts (using heat pump technology as required). Delivery of smelts from the hatcheries is generally carried out by well-boats or specially designed smelt transport trucks.

Sea Farm A/S is actively involved in exporting smelt production technology to other Atlantic salmon-producing countries. Major hatcheries have been constructed in Scotland with majority Sea Farm ownership. In Canada, Sea Farm has entered into an equal partnership with Canada Packers. They have established three smelt production units and two sea cage sites in New Brunswick.

The Committee visited an extensive and recently completed system for marine fish farming. Sea Farm has acquired the rights to a seven hectare marine embayment which has been closed off but still allows tidal exchange. All resident fish in the embayment are removed (by rotenone) and 100 million post-hatch cod are introduced in the spring. Juvenile cod reared in this embayment (approximately 200,000 in 1987) are harvested in the fall by seining and transferred, as 20 gram "fingerlings", to sea cage operators. A nearby saltwater hatchery has also been constructed for juvenile halibut.

An experimental sea cage culture site for marine fish was also visited. Sea cages were inside a covered floating structure where feeding and grow-out trials were planned using juvenile halibut. This impressive research facility had only recently been completed and experiments had not started. It was clear that Sea Farm was making significant R&D investments in marine fish culture.

III—SINTEF: THE FOUNDATION FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (TRONDHEIM)

The SINTEF Group is a consortium of four separate technology institutions which perform contract research for industry and government in close cooperation with the Norwegian Institute of Technology, an academic institution. SINTEF is Scandinavia's largest contract research organization with approximately 2,000 employees of whom 1,000 are professionals or research scientists. Some 200 scientists employed by SINTEF also work in various universities.

SINTEF is active in most technological fields but particularly in marine technology. SINTEF's total budget last year was about $180 million. Most of SINTEF'S income is derived from research contracts with the private

and public sectors, with some from research contracts performed for the Norwegian Research Council but very little from general government grants. Some income is derived from the patenting of new discoveries.

SINTEF has some 22 divisions, some affiliated institutes and three related companies, including the Marine Technology Institute, which the Committee also visited. Aquiculture research activities are carried out in seven of these divisions, as follows:

A. Processes for Intensive Fish Farming:

1. Flatfish Broodstock Research

One objective is to control spawning so that it occurs throughout the year; this is accomplished by varying the light and temperature conditions of different broodstock groups as these variations affect the development of the reproductive glands. This ensures a steady supply of egg throughout the year for research purposes and also has commercial implications. It should eventually alleviate production bottlenecks. Flatfish spawning normally occurs during a period of 6 to 8 weeks during March to May. This research has apparently increased the spawning period up to six months. Egg quality is also improved by increasing temperature and by adding vitamins to the broodstock's feed.

2. ***Research in Feed Composition, Production and Feeding Technology***

Research into the composition of live feed has so far increased the survival rate of flatfish larvae from 5% to 50%. The quality, composition and nutritional value of living feed (zooplankton, rotifers, algae) has been increased by using various yeast cultures. Previous research in this area for salmon is being applied to the culture of flatfish. Research into the use of different binders of vegetable origin to increase the nutritional value of fish feeds is also being carried out.

3. ***Transport of Live Fish***

The possibility of transporting live fish in oil tankers is being studied. This would require that pressure be built up in holding tanks in order to minimize wave action and to maintain suitable oxygen levels to reduce stress on the fish. The effects of this increased pressure on the fish are being studied. The foregoing, as well as other research into the various means of

transporting live fish, shows that the Norwegians are conscious of the need to reduce their transportation costs and increase transportation capacity to compete in markets such as the U.S. and Japan.

B. Structural Strength of Sea Cages

Research into evaluating and calculating the stress resistance of new cage structures and anchoring systems enables fish farmers to avoid over-building, thus reducing initial capital costs. This research and that described in the following section is based on technology and expertise developed for other industries such as the marine oil and shipping industries.

C. Other Types of Fish Farming Units: Land or Sea-Based Closed Plants, Ocean Cages

The current Norwegian aquiculture industry is based on open sea cages, a relatively simple technology which has been very successful to date. However, as site availability for the application of this technology diminishes, research is being conducted into other types of fish farming units. One problem with the existing technology is that the fish are trapped in the top 5 to 10 metres of the ocean's surface which prevents them from moving to escape changes in the surrounding environment. For example, there are great variations in temperature and salinity along the Norwegian coast depending on the time of the year and the amount of rainfall. A minimal change in salinity will cause the fish to lose appetite for several weeks, thus reducing growth. There are also problems with toxic algae and jelly fish which clog the nets (reducing water exchange) and affect fish respiration. Wreckages and safety of the work environment are also problems.

The most important factor for a fish farm is its location; local current conditions and water exchange rates are crucial for the dispersal of waste products and the maintenance of a healthy environment for the fish. The Norwegians believe that environmental degradation is the major cause of their current disease problems in some areas. Various ways of dealing with this problem are being studied.

Studies have shown that pumping water (to increase the water exchange in sheltered inlets) adds about $0.25 to $0.50/kilo on a total average production cost of $6.6/kilo. Another possibility would be to move farms into more open waters so as to provide a better environment for the fish. This would also take pressure off immediate coastal waters. This requires

designing "ocean cages" which can withstand waves of 3 to 5 metres, to a maximum of 6 to 10 metres. The surface units, nets and anchoring systems must be carefully designed to achieve the necessary flexibility. Another possibility is the use of closed or partially closed systems anchored off-shore. Because of their closed walls these systems would be subjected to much higher wave and current forces and would thus require stronger anchoring.

Another development in this respect is the designing and testing of submersible cages. This concept provides a number of advantages: the depth at which the cages are submerged can be varied depending on wave action and water temperature. Wave action is strongest on the surface of the water which is stressful for the fish and can have a direct impact on fish health. The fish in submersible cages can be fed with flexible tubes from a surface platform. An experimental submersible system will be tested in 1988. It is thought that the water quality is better beneath the halocline, 30 to 50 metres below the water's surface, a depth where stable temperatures and a more constant water quality is maintained all year round. In Norway, surface temperatures can fall to 1 to 2 degrees Celsius in winter, which reduces the salmon's growth to practically zero. Thus, during a period of 5 to 6 months, the fish is simply in "storage" and growth is limited. If the fish can be kept in water of 5 to 6 degrees Celsius, annual production can nearly double. Also, with better water quality, various diseases can be avoided and costs related to medical treatment can be reduced. A challenging aspect of research into the use of submersible sea cages is the design of the mooring system. These cages can be brought to the surface using ballast systems. To avoid rapid changes in pressure which could adversely affect the fish, the cages should not be brought to the surface too quickly.

The foregoing advantages can also be achieved in partially closed or closed systems in open waters by pumping water up from beneath the halocline. Water current conditions can be better controlled in systems in open waters and will allow higher densities of fish because of the water movement. Also, feed conversions are improved in closed systems and it is easier to monitor fish feeding. Theoretically, the feed conversion ratio could eventually be reduced to 0.9:1.0. In a land-based plant operated in Iceland by a Norwegian company, a feed conversion ratio of 1.1:1 has been achieved. Generally, the ratio varies from 2:1 to 1.5:1 in Norway.

D. Chemical and Physical Environment in Fish Farming Units

This research deals with the environment in rearing tanks: water exchange, oxygenation, water treatment and quality as well as temperature control to reduce energy costs.

Studies of various water exchange systems have been carried out. The water exchange system is important to maintain continuous water circulation in a rearing tank, the objective being to provide good water quality throughout the tank. Also necessary are bottom currents that can carry wastes to an outlet. To do this, one must be careful how water is pumped into and distributed within the tank. For example, the traditional water exchange system used in rearing tanks in Canada and Norway does not provide an optimal oxygen content and this negatively affects the salmon's growth. Research has shown that a number of very minor changes to the traditional system can ameliorate the physical environment in rearing tanks.

Water treatment systems are important because they permit the recycling of heated water, which reduces energy costs. Traditionally, water treatment is carried out by collecting the water from all rearing tanks into a central treatment plant where ammonia and particles are removed. This involves a certain amount of risk because, when a water treatment system fails, all tanks are equally affected. Thus research is being carried out so that eventually each rearing tank will be equipped with its own water treatment system. A system giving promising results has been developed and will soon be marketed by the companies funding this research.

E. The Development of Instrumentation

SINTEF has adapted existing knowledge and technology to develop the hardware and software necessary to monitor and control the water environment in rearing tanks; eg., oxygen content and temperature of the water. This technology is now relatively widespread in Norway and will presumably be commonly used in Canada as well.

Other work in this area is aimed at developing acoustic instruments to record the weight and size of farmed fish without removing them from the farm unit. Such instruments will eventually be used to evaluate the behavioral and physical characteristics of the fish, such as movement and cardiac activity. Work is also underway to develop instruments capable of

measuring feed wastage and methods of providing feedback to automatic feeding units.

F. Marine Technology Research Institute: (Marinetek)

Marinetek is involved in developing type certification standards for fish farms in response to industry and insurance safety requirements. This is an interesting example of industry self-regulation. There are apparently no governmental standards in this respect.

Other research carried out at Marinetek deals with the following: 1) a three-year simulation program for fish plants, 2) a flow-through study program on the nets of the sea cages relating to the shielding effect caused by a row of cages (this affects the structural stress on the fish farming unit as well as the water exchange and oxygen content in the cages), 3) evaluation of new construction materials and 4) anchoring analysis.

IV—FFSO: THE FISH FARMERS' SALES ORGANIZATION

A. Marketing Information

The latest available figure on the number of hatcheries is 611, based on the number of licences issued by the Directorate. There are 728 licences for salmon and trout farming and 167 licenses for shellfish and new species such as cod and halibut, though not all these licences are operational. FFSO membership is compulsory for all fish farmers.

The FFSO is a marketing organization owned and run by the fish farmers. It is not to be confused with the Fish Farmers Association, which is a producer association. All farmed fish must be sold to the FFSO, which sells it to a network of fish brokers and 78 licensed exporters. The FFSO is funded by a 1.5% commission paid by the fish farmer and a 1.5% commission paid by the buyer. The funds collected in this way are spent on marketing quality improvement, product development, etc. The FFSO encourages the use of a Norwegian salmon trademark to promote its product. There are three quality grades for Norwegian salmon: superior, ordinary and production.

The FFSO'S Marketing Council comprises the FFSO fish farmers and the buyers/exporters. Its 1987 budget is in the order of $5 million, up from $2.5 million in 1986, and this is expected to increase again next year,

although not so substantially. The 1987 increase was required because of production increases and competition emerging from other countries, such as Scotland. In addition, the exporters engage in their own marketing activities, also at a total cost of about $5 million, partially funded by the FFSO. The importers around the world who buy Norwegian fish also engage in marketing activities: these are presumably funded by the FFSO. These total marketing expenditures of $10 to $14 million represent about 2 to 3% of the first-hand sales value, which is expected to reach $440 million in 1987. Indications are that marketing expenditures have doubled since 1985.

The larger part of the Norwegian farmed fish production, about 90%, is exported, with the main markets being the United States and France each of which in 1986 absorbed a little over 10,000 tonnes. The third biggest market is Denmark, which absorbed in 1986 nearly 6,000 tonnes. About half of the salmon exported to Denmark, is being re-exported into the EEC after having been smoked. Denmark's EEC membership enables it to avoid the 13% tariff Norway has to pay on smoked salmon exports to the EEC. The EEC tariff on fresh salmon is only 3%. The EEC also has a 13% tariff on trout (fresh) because of the very heavy trout production (about 150,000 tonnes) in France, Italy and Spain and, of course, in Denmark. Another major market for Norwegian salmon is Germany, which has high income levels and a large population (61 million people). Another increasing market is Spain, which absorbed 1,800 tonnes in 1986.

The Marketing Council has to date established offices in France and in Spain. Other offices will be opened in West Germany and the United States. The likely location in Germany will be Hamburg, the fish capital of Germany; in the United States, it will be either Boston or New York.

Another interesting market is Japan. To date, it is only absorbing very small quantities: 1985-400 tonnes; 1986-850 tonnes; 1987—1 ,500 to 2,000 tonnes. Because of the distance from this market, shipping fresh product is difficult. As a result, much of the product is exported in the frozen form. The Japanese are so quality minded that fish destined for this market must be earmarked as early as the feeding stages and the slaughter and freezing processes are also highly controlled. Japan is expected to be an increasing market once these difficulties have been overcome.

Another growing market is Italy, although import restrictions are very heavy. A marketing office is to be opened in Milan and increased marketing promotion will then take place.

Finally, a few unsuccessful attempts to market salmon in the U.S.S.R. have shown that the major potential of this market lies in sales of fish farming supplies and equipment.

The prospect of a U.S. compensatory tariff of 5 to 6% on Norwegian farmed salmon is indeed of concern to the Norwegian aquiculture industry, as the U.S. absorbs more than 20% of its production. To counter European protectionism, Norwegian exporters are establishing smoking operations in the EEC; one of the first locations is to be in Germany, followed by one in Spain. Scottish production has already displaced Norwegian production in the United Kingdom and it has increased its penetration of the French market; however, the Norwegians retain their leading edge there because of the real or perceived superior quality of their product.

B. Industry Information

Since October 1985, the FFSO has had all rights for the trading and marketing of all species of farmed fish, and shellfish. To date, 90% of the volume handled by the FFSO has been composed of salmon, another 5% has been composed of trout and the remaining 5% of other species. The next species the FFSO expects to be handling is farmed cod. In 1987, some 50 tonnes of whole or gutted cod were marketed at $5/kilo, which is substantially above the landing price. Sales are expected to amount to between 150 and 200 tonnes in 1988. Because of the small quantities sold to date, it is, however, not yet known whether farmed cod will, because of its better quality and freshness, continue to command a higher price than the wild product. However, the FFSO is satisfied with the prices it has been able to negotiate with the buyers so far. Whether cod farming will be successful depends on the production cost of farmed cod and whether it will be competitive with the wild fisheries. Conflicts are arising in this area and in this respect, trilateral discussions are taking place among the FFSO, the commercial cod fishermen and the government. Discussions are also taking place to define clearly what constitutes a farmed product: the FFSO position is that a farmed product starts with the reproductive process. This distinguishes fish farming from the rearing of fish caught in the wild.

C. Research and Development, Diseases, Veterinary Services

In response to an inquiry, it was stated that tax provisions do exist in Norway to stimulate research and development, but that in-house

private-sector research and development has been done by the larger farms only; eg., Sea Farm and MOWI.

The initial R&D in the field of aquiculture was done by the agriculture-oriented governmental experimental stations. Most of the R&D in aquiculture is still carried out by the government, although there are a number of private research organizations in operation and some R&D in aquiculture is the result of cooperative efforts between government and industry. However, according to the FFSO, the government is still not funding enough R&D, particularly on fish health. As a result, the FFSO has had to contribute $3 to 4 million to this during the past five years.

The FFSO has initiated a cooperative research program among various scientific organizations in Norway entitled "Fresh Fish". The main goal of this program was to find a cure for the Hitra disease, and a vaccine developed by the Fresh Fish Group seems to work. Preliminary results indicate that on the three farms affected by the Hitra disease this summer, 29% of the unvaccinated fish contracted it, while only 1 % of the vacinnated fish did so. It has been determined that the Hitra disease is a bacterial infection, although its origin is not yet known. It is suspected, however, that the disease is caused by environmental pollution emanating from fish farms. The Norwegian industry seems to have the attitude that diseases are here to stay and that one must learn to live with them, assuming that they pose no problems to consumers' health.

The FFSO is of the opinion that in 1987, up to 60,000 tonnes could have been marketed without any difficulty, had this quantity been produced. In 1986, however, disease-related losses of between 5,000 and 10,000 tonnes caused a shortfall in the 1987 level of production. As a result, prices in 1987 were quite high. The FFSO estimates that international markets can still absorb tremendous quantities including those yet to be produced by Scotland and Canada. The FFSO has revised the 1987 estimated production levels from 53,000 tonnes to 47,000 tonnes and emphasizes that this is exclusively related to the disease situation and not to the market's ability to absorb these production levels.

There are indications that the strong annual real price increases that characterized the earlier growth phases of the Norwegian industry are a thing of the past. Substantial price variations in recent years tend to indicate that production levels may have reached a price-elastic portion of the demand curve. This suggests that caution is required on the part of new entrants to

the industry. It is important to note that even prior to these revisions in estimates, production was expected to level off at around 80,000 tonnes in 1989. It is now expected to level off at 74,000 tonnes although the industry's current capacity is estimated to be as high as 100,000 tonnes.

Inadequate fish veterinarian services were a problem in Norway as far back as 1977. According to the FFSO, there is still no specialized educational program on fish health for veterinarians. The FFSO maintains that it is up to the government to address this situation. To compensate for this lack, the FFSO has had to fund research in this area. It advocates a freeze on licences pending an expansion of the infrastructure services provided by the government. This position, combined with the increasing pressure from the farmers to allow increases in the scale of operations, seems to indicate that attempts are being made to restrict entry into the industry. In real terms, the cost of entry has increased substantially over the years as the government apparently withdrew start-up grants etc. as the industry proved itself viable. This has not, however, prevented the number of applicants from increasing, showing that the industry is still offering relatively high returns.

This raises the question of why an industry showing such high rates of return has not itself funded the required expansion of the infrastructure. According to the FFSO, the earlier successes of the industry led the government to limit the funds it put into developing the required infrastructure. FFSO maintains that most of its own responsibility lies in developing quality standards and ensuring that the industry regulates itself in this respect. The Quality Control Department of the Fisheries Directorate in Bergen does spot checks on quality but its resources are insufficient.

As a partial solution to the lack of veterinary services some fish farmers have jointly hired a veterinarian. Previously, veterinarians lived in rural areas but now it seems it is difficult to attract them into the outlying districts where the fish farms are located. Other solutions would be the creation of a specialized educational program in fish health, and ensuring that veterinarians would be available in outlying areas by having them employed by the Fisheries Directorate.

There is some measure of governmental control of fish health. For example, the 300 to 400 fish farmers exporting to the U.S. are specially licensed and are required to send their fish four times a year to the Veterinary Institute in Oslo to be checked. This system, to which the Norwegians are bound by international agreement, seems to have been

created in response to the demands of importing countries such as the United States and Italy. It seems, however, to be insufficient for disease monitoring.

V—THE ROYAL NORWEGIAN MINISTRY OF FISHERIES: (OSLO)

This Ministry is composed of about 80 people and is the Minister's "inner secretariat". Within the Ministry, there are two divisions related to aquiculture, one of which is concerned with aquiculture R&D and the other with management and regulatory issues.

At the level below, the Fisheries Directorate ensures a local presence with nine regional directors, each with their own staff. Also, at the municipal level there are 63 fisheries advisers who give advice to local fishermen and fish farmers.

A. Regulations, Licensing and Infrastructure Requirements

Size and ownership regulations were discussed. Regulations require majority holdings by local capital as opposed to large industrial concerns. This has incidentally also prevented foreign investment in the Norwegian aquiculture industry regardless of size. The tight control exercised on the scale of operation originates from two concerns: that aquiculture should stimulate regional development, and that production should not exceed the absorption capacity of the market. The stringent ownership and size regulations have been major factors in the establishment of Norwegian aquiculture companies abroad.

The Ministry decides on the number of licences to be issued annually and their locations. The Fisheries Directorate then selects the applicants to receive a licence. Anybody receiving a refusal can appeal to the Ministry only on technical grounds; i.e., mishandling of an application. There is apparently very little room for political interference in the licensing process, which is very long: it may take up to a year to receive an answer to an application. The Ministry is considering charging fees for handling licence applications, and the money will presumably go towards hiring more staff to handle the number of applications. The process includes sending the application to the local representative of the Fisheries Directorate, who determines whether the site of a particular licence application satisfies traffic regulation, pollution and disease controls. Other government departments,

such as the State Pollution Control Authorities, the Ministry of Agriculture and the National Coastal Administration are also involved.

Licences are transferable but transfers are subject to conditions. The purchaser must be approved by the Fisheries Directorate. In the case of a joint stock company, a majority interest selling its shares in an aquiculture company has to have the buyer approved by the Directorate. A minority interest selling its shares has to register the transaction with the Directorate. Thus, at any time, the Directorate knows the owners of each permit. This knowledge is important, since the initial decision to issue a permit was based on knowledge of its original applicant.

The Ministry has a right to revoke a licence (under Part 11 of the Act) in predetermined circumstances. One of these is the inactivity of a licence or its limited use, since this may affect the supply/demand situation. A licence may also be withdrawn if the facility causes, or involves the risk of causing substantial damage through pollution or the spread of diseases, or poses a danger to traffic or other types of use of the area. However, the licence may not be withdrawn if the damage can be repaired or the location changed by order of the relevant authorities. Ministry officials thus consider that the power to revoke a licence is more theoretical than practical.

The permits are issued on an individual basis for specific localities and with the size restrictions in force at the time of issue. The fact that licences are individual prevents the merger of aquiculture companies but does not exclude the forming of consortia for purchasing production services and inputs. This practice has in fact become quite widespread and is even encouraged by the authorities.

The question of increasing the size limits of fish farms was studied by the Fish Farmers Association at its annual meeting in March 1987. There is obviously increasing pressure being exercised on this issue by farmers who fear the erosion of their competitive edge. A Ministry report presented to Parliament stated that the possibility of increasing the size of operations to 10,000 m or 12,000 m would be considered but nothing definite has yet been done in this respect.

The even distribution of aquiculture companies in the more sparsely populated areas of Norway shows that the regulations restricting size and ownership can be considered a political success. The initial objective was to have small owner-operated farms (possibly on the level of a cottage industry),

which would contribute to stimulating regional development. Would the industry have been even more successful under less restrictive policy guidelines? [t would seem that the Norwegian authorities themselves are sometimes still surprised by the success of the aquiculture industry.

The FFSO and FFA both adopt the position that no more licences should be granted prior to an expansion of the infrastructure, especially as it relates to fish health. At the same time, there is increasing pressure from the FFA to increase the scale of operations. These two aspects of this position are somewhat contradictory.

The Government has one view of what the public infrastructure should be; the FFA has another: an expansion of the infrastructure without cost to the industry. According to ministerial officials, this situation is usual in any profitable industry. The fish farmers want to restrict access into the industry and are pressuring the government in this regard; on the other hand the government wants to allow as much access to the industry as is economically feasible, given that it wishes to maximize the economic benefits to be derived from the industry. Also, the government must contend with the political pressure being exerted by those wishing to enter the industry.

Notwithstanding the above, it is the Ministry's belief that the infrastructure problem is real. This question is discussed in the report to Parliament. There is a need for an expanded public infras-tructure, including the capacity to handle licence applications quickly and thoroughly. The industry's concerns with respect to the infrastructure relate mainly to fish health protection and veterinarian services. The fish farmers compare themselves to the agriculture industry, for which there is no shortage of veterinarians, even in the more distant rural areas. The demands of the fish farming industry have not generated any particular outcry from the public since other industries, for example agriculture, has in the past been provided with extensive public infrastructure services. The main industry argument is that fish farming, a relatively new industry, should be provided with the same level of support. Within the government, particularly the Department of Finance, this attitude is reversed. Requests for more appropriations to increase the level of service to the industry are not being acceded to because of the industry's high levels of returns and overall fiscal considerations.

Of the 900 or so aquiculture licences issued in Norway, over 160 are for non-traditional species. To encourage this type of fish farming, there are no quantitative restrictions on the number of licences issued for

non-salmonid species, including shellfish such as mussels; a crop of about 300 tonnes is expected for 1987. This is down from 500 tonnes in 1985 and may indicate some problems.

B. Financing

In 1987, there were about four bankruptcy cases in the aquiculture sector, two of which were particularly difficult cases because of the large amounts of money involved. The main reasons for such bankruptcies are said to be diseases and bad management. Farmers who have financially over-extended themselves are not in the best position to deal with a crisis situation should it arise.

Recent failures have led the banks to push more forcefully (but without success) for a change in regulations so that licences could be mortgaged. This would enable banks to sell the licences to the highest bidder in the event of a bankruptcy. At present, the banks must have the prospective buyer approved by the Fisheries Directorate, which establishes whether he fulfills the legal requirements.

As licences are not completely transferable, in theory they have no face value. A licence has a monetary value in practice, however, since in the event of a bankruptcy, a bank will seek to sell the facility and, by implication, the licence, to a qualified person. The Ministry officials are aware that they are treading a fine line in this area. On the one hand, they do not want to abandon their prerogatives. On the other hand, they do not wish to see the banking sector restrict its financing of the aquiculture sector because of inflexible regulations. As a result, they have handled the four bankruptcy cases that occurred in 1987 as delicately as possible. Ministry officials partly blame the banks for insufficient follow-up of customers, and presumably lack of management advice, after the loan has been contracted. This may be important for the development of the Canadian industry, where some amount of management advice will presumably have to be provided by government experts.

While it was initially possible to insure against losses due to diseases, the Norwegian insurance industry is withdrawing from this type of coverage. As a result the FFA has decided to establish its own cooperative insurance company, while other fish farmers are seeking insurance services abroad; for example, from Lloyds of London.

VI—NORWEGIAN BANKS: (OSLO)

The Norwegian banks represented at the meeting included the Christiania bank, the Focusbank and the Bergenbank. Together with the Norskbank and the Kreditkassen, these banks are those most involved in financing aquiculture both in Norway and in other countries, including Canada. Also represented at the meeting was the Industry Fund, a public sector institution.

A. Funding by Banks

The Norwegian banks have been involved with the aquiculture industry in Norway for over 20 years. The beginnings of the industry had a number of failures and unprofitable operations. More recently, due to the restrictive domestic regulation of the Norwegian aquiculture industry, the banks have financed the establishment of Norwegian aquiculture businesses in a number of countries abroad, including Canada, the United States, Scotland, Ireland and Iceland. They are also very much involved in financing exports of aquiculture-related equipment and technology. It was asked whether the financing of Norwegian companies in Canada was tied to the purchase of Norwegian equipment; the reply was that, while there were no such requirements, Norwegians establishing themselves in Canada had a natural tendency to use Norwegian equipment.

The initial attitude of the banking sector towards the budding aquiculture industry was possibly conditioned by the fact that such financing involved, at first, relatively small amounts. One reason for this may have been that government subsidies were more generous in the past than they are today so that the risks involved for the banks in each transaction would have been smaller. It would seem that the larger investments at the beginnings of the industry were backed by large industrial corporations. Today the banks still find it easier to finance ten small farms than one large farm, as the risks are spread. Also, the presence of a central marketing organization is seen as diminishing the risks involved in financing aquiculture ventures. The banks can rely on the fact that a producer they have financed will benefit from the FFSO'S market power and obtain the best possible market price. This situation may, however, be changing as there have recently been decreases in the price of Norwegian salmon. In evaluating the risks in each transaction, the banks rely on the expertise of employees with a technical knowledge of the industry, such as former fisheries officials.

Possession of a licence is no longer sufficient to obtain financing. The licensing system has been studied by the banking sector, which favours full transferability with no strings attached. However, this question has not yet been resolved in their favour: licences are not mortgageable. In British Columbia the situation is better, since the provincial government allows licences to be assigned by way of mortgage.

Until recently, Norwegian banks required relatively small amounts of equity on the part of the prospective entrepreneur in an aquiculture venture. It was also relatively easy for someone with an aquiculture licence to get some financial backers or minority partners able to put up equity. However, as disease-related failures and insurance problems increase, the banks are demanding higher percentages of equity. Until recently, equity requirements varied around 10% with the remaining 90 to 95% of capital loaned by the banks being insured and also supported by loan guarantees provided by public sector institutions.

The amount of equity required from the entrepreneur also varied in relation to his experience and past performance in the field of aquiculture. As low as 5% equity could be required from a highly qualified entrepreneur with a good track record who wanted to set up an aquiculture venture in Norway or abroad.

Bank financing of aquiculture ventures is generally in two parts: a term loan to handle capital start-up costs and a revolving credit on an annual basis to finance operating expenditures.

There has been a great deal of financing of Norwegian investment in Canada over the past few years. However, the banks have recently slowed down their activities in this area and are awaiting the financial results of the investments already made in B.C. The years 1988 and 1989 will be crucial in terms of the return cash flow from Norwegian investments in Canada.

Much is made of the Canadian banks' reluctance to become involved in the Canadian aquiculture industry and assume some risk in this area in cooperation with the Norwegian banks. It would seem, however, that the Norwegian banks were as risk-averse as their Canadian counterparts in the initial stages of the industry's development and that their risk aversion may also increase in the future. The involvement of the Norwegian banking sector was favoured by the very gradual development of the industry when it was

still limited to trout farming. In addition, the public sector seems to have undertaken a substantial amount of risk sharing by providing loan guarantees and reducing the real costs of entry into the industry with grants and subsidies.

B. Public Funding

A public sector institution providing grants, loans and loan guarantees in Norway, and involved in aquiculture financing, is the Regional Development Fund. In Norway, aquiculture has been used to stimulate regional development and most fish farms are located in rural areas. While the Regional Fund has decreased the proportions in which it finances aquiculture ventures, financial aid is still available, depending on the location of the projects.

Grants may represent up to 25% of capital costs (down from a previous level of 35%). Loans may represent up to 50% of capital costs and the interest on these loans would be in the order of 11.5% compared to 14% on long-term loans and about 18 to 20% on working capital loans offered by the banks. In exchange for a fee paid by the farmer, the Regional Fund will guarantee up to 50% of the value of working capital loans taken out with a bank, the remaining 50% of the loan being covered by the bank.

Thus there is substantial public sector involvement in sharing the risks of financing aquiculture ventures. These guarantees have substantially increased the willingness of banks to get involved in this sector and the availability of funds for the industry's development. They do not apply exclusively to the aquiculture sector. The fact that these grants and guarantees promote regional development and are available to industrial sectors across the economy reduces the risks of their being subject to counteravail actions either under U.S. trade law or the GATT.

Another government institution involved in aquiculture is the Norwegian Industrial Fund. Its objective is to stimulate industrial growth and adjustment in order to strengthen Norway's competitive position. The Fund offers grants, loans and guarantees for industrial projects both at home and abroad, but only after all other financial sources have been explored.

The Fund does not finance aquiculture ventures in Norway directly, although it has two programs which apply to the aquiculture industry among others. One of these is designed to finance the development of new products

by the aquiculture equipment industry: loans for research and product development may be granted without any forms of security and are normally written off partially or fully if the project turns out to be commercially non-viable. In 1987, some 30 projects were funded under this program for a total value of $6 million and funding is to be increased as a result of the most recent budget, which provides for a 40% increase in state-backed research in 1988 to help Norwegian small and medium sized businesses regain market shares lost at home and abroad. Aquiculture is one of the four industrial sectors targeted by this $70 million increase in state-backed research.

The other program provides loans for the "internationalization" of Norwegian companies, including aquiculture ventures. Internationalization is the establishment of sales or manufacturing companies abroad. Loans for this purpose have been made mostly to Norwegian and American companies which then lend the money to the persons setting Up the Canadian operation. The loans represent only as much as the equity put into the projects by the Norwegian investors.

In 1986, the Fund financed five aquiculture ventures in Canada (mainly on the west coast) involving total amounts of $5 million U.S. The financing of joint venture aquiculture projects abroad is conditional upon majority ownership by people already involved in aquiculture in Norway. Also, the Fund prefers to finance ventures which are vertically integrated, comprising a hatchery, a grow-out facility, a processing operation and a marketing arm. The obvious reason for this is so that Norwegian company management can retain as much control as possible over the whole of the production process. As a result, the size of the projects financed has been quite large.

III—INSTITUTE OF AQUACULTURE RESEARCH: (OSLO)

A. Description of the Institute

The Institute is a relatively new organization created in 1984 by the Agricultural Research Council of Norway for the purpose of administering two aquiculture research stations set up in the early 1970s. The Committee visited the main unit of the Institute, at the Agricultural College of Norway near Oslo.

The Institute's income comes from three different sources: 10% is from grants contributed by the Agricultural Research Council of Norway; 70 to 75% is from the sale of fish; and research contracts with private and/or public institutions account for 20 to 30% of its income.

The Institute is involved in the following major fields of aquiculture research: 1) genetics and breeding, 2) nutrition and feeding, 3) health, 4) new species, 5) technology and fish husbandry.

B. Presentation by the Institute's Research Staff

1. Genetics and Breeding

Research on breeding and genetics has been mainly devoted to a salmonid breeding program being developed since 1975/76. Its major aim is to enhance the growth rates of fish. Experiments revealed that there was a 30% hereditary component to the growth rate; i.e., 30% of the change in the growth rate can be attributed to genetic effects. Another aim of the breeding program is to retard sexual maturation so that the fish will grow as much as possible before they mature and stop growing. Later sexual maturation has been found to be 25% hereditary. The commercial implications of extending the salmon's growth phase are obvious.

From the genetic and breeding research done to enhance growth rates, the physical characteristic most closely linked to disease resistance appears to be the weight of the fingerling. The research carried out to date has not identified a genetic parameter specifically correlated to disease resistance. Being researched are the relationship between the level of antibodies and hormones (e.g. cortisol) as well as blood sugar levels. These two physical traits are related to the ability of fish to withstand the stress undergone by wild fish in captivity. The level of stress is inversely related to the ability of the fish to withstand diseases. The search for the parameters of disease resistance will continue, as immunity to certain diseases (such as vibriosis and the hemoragic syndrome) has been shown to be hereditary.

Here is a possibly important lesson for Canadian aquiculture research. More effort should be directed towards determining the genetic basis for improved disease resistance. In this way, disease resistance could be incorporated into the breeding programs developed for farmed fish in Canada, whether salmon or other species. According to Norwegian

researchers, it is most likely that flatfish species, which will constitute the next wave in aquiculture, will be as susceptible to diseases as are salmonid species. Flatfish are, however, bottom dwellers so they are more likely to be raised in tanks; these offer greater possibilities of controlling water quality etc. and this might reduce the incidence of diseases.

The breeding programs developed in Norway seem to have emphasized the enhancement of growth rate. This has obviously paid off in the short and the medium term. However, in the longer term, more emphasis on selecting disease resistant strains in Canada may result in even greater rewards,as such stocks would reduce the risk of large-scale crop losses due to diseases.

Comparisons have been made of the growth rates of Pacific and Atlantic salmon. However, no comparisons have been done on their relative ability to withstand diseases. It is known, however, that Pacific salmon are not able to withstand the same levels of stress as Atlantic salmon, and that this has implications for disease resitance.

2. ***Nutrition and Feeding Research***

Nutritional research involves the study of nutritional requirements, feed composition and quantities, nutritional physiology and biochemistry.

The main objective of this type of research is to determine the optimum quantitative ratios between the various components of fish feeds (proteins, fats and carbohydrates) for yielding improved growth. This research is useful for determining the cheapest means of feeding fish while producing maximum growth. For example, research carried out by the Institute has shown that carbohydrates, the cheapest component of the feed, cannot be increased beyond 15%. After that point, the increases obtained in the growth rate level off. The same occurs when proteins are increased beyond 45%. However, fat content can be increased up to and beyond 20% and result in dramatic effects on growth levels. Of course, factors other than feed composition affect growth rates; e.g., water temperature. Much of the Institute's research on fish feeds is carried out under research contracts from private sources such as farmers or feed manufacturers.

Also important in fish feed research are: studies to determine the quantities required and the proper feeding times; searches for better binders (possibly of vegetable extraction) which will not interfere with the digestive

processes of the fish; and explorations of the links between feeds and the health of the fish, the quality of the product (flesh texture and pigmentation) and the effects of feeding on reproduction. This research, in addition to resulting in obvious economic benefits, also explores the link between pollution and fish feeds, given that the most important source of pollution from fish farming is feed waste and fish excrement.

VIII—EXPORT COUNCIL OF NORWAY: (OSLO)

A. Description of Council

The Export Council of Norway is a joint venture between the public and private sectors established some 40 years ago to promote Norwegian exports of goods and services. [t employs about 260 people, of whom 120 work at the head office in Oslo and 140 work in about 48 offices abroad. These offices are integrated with the Norwegian foreign service missions.

Two thirds of the Council budget is financed by an export levy of $0.75 per million dollars. The other third of its budget comes from government funding and cost recovery for services provided, which range from export promotion and market analyses to legal services. It is headed by a board of directors consisting of private and public sector officials. In recent years, the Council has reoriented its activities towards promoting the export of services rather than manufacturing goods as the services category has been growing more dynamically.

B. Discussions on Aquiculture

To date market demand has led aquiculture production. However, the aquiculture industry has been expanding in many other countries, often under the impetus of Norwegians themselves. The export of jobs through foreign investment is accepted as inevitable. The attitude is that this movement towards foreign investment could only have been retarded by a couple of years or so had it not been supported by such organizations as the Industrial Fund and the Export Council. In addition, the Norwegians believe that profits from foreign investment will be repatriated to some extent and that Norway will benefit from the export of fish farming equipment.

In this respect, the Norwegians noted that recent changes in tariff classification had increased the Canadian import duty on fish farming equipment from O to 25%. Previously, fish farming equipment was classified

with specific types of commercial fishing equipment such as nets, net floats, etc. Following a complaint from a domestic manufacturer whose market share had apparently dropped from 50% to 10%, the Department of National Revenue reviewed the tariff classification. As a result, complete fish farms are now classified under the tariff item for "floating structures", which carries a 25% import duty. Complete fish farms or components thereof imported with a view to selling them as complete units are taxed at 25%. Components of fish farms imported to be sold individually are taxed either at the rate applicable to the material they are made of (e.g. plastic, metal, etc...) or at the zero rate on commercial fishing equipment.

This classification change causes some problems for Canadian fish farmers, particularly those importing Norwegian equipment for salmon aquiculture. As it increases both the capital and financing costs of aquiculture ventures, it reduces their profitability. On the other hand, it may encourage domestic and foreign (particularly Norwegian) investment in the fish farming equipment business in this country. In addition to the Norwegian exporters and Canadian fish farmers, B.C. government officials are concerned about this situation. It may have been a better strategy to allow the fish farming industry to establish itself before levying these import duties on fish farming equipment.

Canadian fish farmers may now appeal the recent Revenue Department ruling on the classification of fish farming equipment for each import shipment or group of imports. If they do not obtain satisfaction, they may appeal to the Tariff Board, and then, if necessary, to the Federal Court. The long-term solution is for the Finance Department to change the tariff classification for fish farming equipment. Meanwhile, a temporary change to the relevant tariff items could be effected by order in council.

In Norway, there are no reliable data on the production of the fish farming equipment industry. Nor is there a breakdown between production for exports and that destined for the domestic industry. However, annual investments by Norwegian fish farmers give an estimate of production for the domestic market of nearly $200 million in 1986. A figure on Norwegian investment in B.C. aquiculture in 1986 was also put forward: $10 million.

While some Norwegian investment in the B.C. aquiculture industry has been in the form of imported turnkey projects, most investors buy equipment and components from a variety of Norwegian companies as well as from Canadian producers. The number of Norwegian companies able to

deliver whole turnkey projects (Aquacare, Aquaunique, etc...) is still small as this is a relatively new aspect of the industry. The capital costs of a standard 8,000 m Norwegian fish farm was put at around $200,000 to $300,000 depending, of course on the level of automation and mechanization.

There are at present no land-based farms in Norway that are grow-out facilities. The major problem with such farms in Norway is their energy costs, especially in relation to the pumping, purification and heating of water. All land-based facilities are hatcheries and in this respect, it should be noted that the costs of smelts in Norway are quite high and represent about 10% of the Norwegian farmer's production costs. The flagship for proponents of land-based farms is the land-based operation of a Norwegian company established in Iceland. In this respect, Iceland is in a unique position because of the geothermal sources which provide free heated water. The Iceland (land-based) fish farm has a production cost for salmon of $6.2/kilo. The mean value of the production cost of salmon in Norwegian sea cages last year (1986) was $6.6/kilo, though, of course, there are sea cage farms producing salmon at a cost of $5. O/kilo.

Transportation costs were also discussed. As pressure develops on the Norwegian industry's closest markets such as the United Kingdom, transport costs to more distant markets will eventually become a problem. The Norwegians are exploring a number of solutions: e.g., the use of high speed catamarans instead of trucks to transport their product to the EEC. For more distant markets, such as the U.S. and Japan, the answer will, for the time being, continue to be air cargo, although capacity is limited.

IX—NORWEGIAN PARLIAMENTARY MARITIME AND FISHERIES COMMITTEE: (OSLO)

The Committee members met with their Norwegian counterparts for discussions on the following themes:

A. The Political Repercussions of a Growing Aquiculture Industry

The growth of the industry involved significant government expenditures on capital start-up costs, R&D, etc. The traditional fishing industry believed that too much was being spent on the development of this industry. However, the fact that so many fishermen were involved, and the absence of any substantial commercial salmon fishery prevented this situation from developing into one of real conflict. It is, however, possible that the

development of cod aquiculture could lead to such conflict, as there is an important commercial cod fishery in Norway.

From environmental groups, there was initially little opposition. The number of protests is increasing, however, as the number of farms continues to increase sharply. In addition to environmental concerns, scientists are apparently becoming increasingly anxious about the possibilities of genetic pollution.

B. Trade Considerations

Increasing protectionism is of course of concern to Norwegians; Norway has constantly sought to diversify its markets to reduce its vulnerability.

EEC membership is a hotly-debated question, particularly in the fisheries sector. While joining the EEC would mean an enhanced access to its markets, Norway would also be required to share its fisheries resources, which it already considers insufficient for its own needs. Fish and fish products are imported duty-free into Norway while Norwegian exports of fish and fish products to the EEC are governed by an exchange of letters. Norway is striving to have the EEC live up to the terms of the agreement. This situation is similar to that of Canada with respect to the long-term agreement with the EEC.

C. Industry Regulation

Industry regulation was discussed and the Committee obtained two opposing views. One is that the current regulatory framework of the industry flowing from the Fish Breeding Act , is unnecessary and prevents further expansion, The other is that it is based on specific objectives, such as regional development and job creation, which are best served by maintaining small-scale operations financed by local capital, which has the added benefit of preventing the environmental damage which could flow from large-scale operations financed by big corporations.

I—HIDB: THE HIGHLANDS AND ISLANDS DEVELOPMENT BOARD (INVERNESS)

A. General Information

The HIDB was created in 1965 to stimulate economic development in one of Scotland's most sparsely populated areas. The agency has a staff of 268 people, most of whom are located in Inverness, while others are scattered throughout various parts of the Highlands and Islands.

The principal means used to stimulate economic development are grants and loans and, to a lesser extent, participation in the form of equity. The HIDB primarily assists small business development and is involved in a broad range of industrial sectors, including tourism and aquiculture. Two thirds of the HIDB's budget is obtained from the government and one-third from income generated by the Board's activities.

While Scottish aquiculture was initially associated with big business, the Board has helped many small businesses enter the industry. The assistance provided for aquiculture, particularly salmon aquiculture, has decreased substantially in recent years and in most cases, is now just sufficient to trigger financial assistance from FIOGA, the EEC fund which provides financial assistance for the capital costs of setting up aquiculture ventures. The Board sees future activities mainly in the marketing of aquiculture products. It is trying to encourage small farmers to market cooperatively in order to face the increased competition expected from the Norwegians after they have solved their disease problems.

B. History of the HIDB Involvement in Aquiculture

Starting in 1965-66, the Board backed many high risk ventures, each involving relatively small amounts of money. Around 1970, it was thought that oyster and trout farming had good potential, given that these were two products traditionally consumed in the United Kingdom. The prospects for this type of aquiculture were not realized, however, especially for oysters. Trout aquiculture grew somewhat but quickly levelled off. It became apparent that the prospects for mussel and salmon farming were much better.

As early as the mid-sixties, Unilever Corporation was involved in pioneering salmon aquiculture. It bought from Norway what were purported to be fairly complete installations for salmon aquiculture. This attempt proved, however, that the direct transfer of technology was not the recipe for success. Subsequently, this company put substantial funds into development of a technology adapted to the Scottish conditions with financial assistance from the HIDB.

In the late 1970s, it gradually became clear that the farming of Atlantic salmon was developing into what could be called an industry; it started to make substantial profits on a year to year basis. After that, many other large companies started getting into the business. Many people previously employed by Unilever Corporation started their own enterprises or were enticed to work for other large corporations wanting to get into aquiculture. Unilever responded by attempting to patent (in the UK as well as in other countries) the technology it had developed. These attempts were successfully fought in the courts by industry participants including the HIDB, which considered that it had financially contributed toward the development of this technology.

At that stage of the industry's development, the early 1980s, the HIDB was not yet backing the entry of small business into the industry because substantial amounts were still required to set up operations. As the industry became more established and the capital costs necessary to enter it decreased, the HIDB gradually started to divert its assistance to smaller and smaller production units. The only way smaller operators could be brought into the business was to tailor HIDB assistance to their needs by way of grants and loans.

The HIDB started a program designed to assist the development of 20-tonne salmon farms. These are basically one or two person operations with an $190,000 capital cost requiring owner equity of 5 to 10%. This level was selected because it enabled people with between $9,000 to $19,000 of equity to enter the industry. A 20-tonne or 1,000 m farm (assuming a density of 20kg/m) is a 10,000 smelt grow-out operation with about 350 smelts producing a tonne of product. At this point, the HIDB was seeking to promote a cottage industry. Although this scale of operation was considered to be on the edge of the minimum requirement for viability, it was also thought that the more successful producers would be able to expand their operations to 30 or 50 tonnes by applying for further financial assistance. This program apparently had a high success rate, both because these smaller

operators were setting up in an already established industry and because some of them had gained experience in aquiculture from working in the larger companies. HIDB officials also noted that this program was successful in an area where mussel farming was also being encouraged. Mussel farming was not as successful, even though in theory it lends itself well to a small scale of operation as it does not require the same constant monitoring and attention as salmon aquiculture and so allows the mussel farmer to supplement his income by engaging in complementary activities. The more successful mussel farmers are those who have moved quickly into an expanded scale of operation.

The HIDB also supported the development of a large number of small hatcheries, taking the view that an oversupply of smelts was easier to deal with than a shortage of smelts. At one point, smelt producers in Scotland were considered to have a "licence to print money" because of the shortage of smelts in the Norwegian industry. This profitable export venue dried up as the result of the sale of diseased smelts to Norway by one producer. This did not, however, overly constrain the development of the smelt industry in Scotland.

The smelt supply in the United Kingdom is self-contained as the fish health laws permit the importation of eggs but not of live fish. The Scottish industry is still using Norwegian well-boats for the transfer of smelts to the grow-out facilities. It is expected, however, that the industry will shortly be building its own boats in Scotland.

C. Present Situation of Scottish Aquiculture

The rapid growth of the Scottish industry led to conflicts with other water users, as well as worries that production was outstripping market demand. This latter worry proved to be groundless; markets kept expanding as the industry increased its production. The acceptance of new applications for assistance was facilitated by the fact that most of these new production facilities were aimed at supplying previously unserviced markets. The situation is not as simple now since new production facilities often aim to supply already serviced markets thus leading to increased competition. Nonetheless, the Scottish industry considers that it has barely scratched the surface of the European market and the United States market. The Scots are, however, not optimistic about the Japanese market, which the Norwegians are trying to develop.

The Scottish aquiculture industry does not have an organization like the Norwegian FFSO, which controls the marketing of the industry's production. The Salmon Growers' Association is mainly engaged in generic promotion. The SGA and the HIDB are, however, cooperating in developing and encouraging the use of the Association's Seal of Quality by those members meeting the standards of its quality control scheme.

Though cooperative purchasing (of production inputs such as feed) has functioned very well among the small Scottish producers, the industry has a number of difficulties in getting small operators to cooperate in marketing. The HIDB and the Scottish Salmon Growers' Association have been trying to reorganize the small producers to enable them to provide a continuous supply of salmon to large customers requiring several tonnes on a weekly or monthly basis. Cooperative marketing would also enable the small producers to get better prices by unloading production in times of relative shortage.

Large operations generally sell 50% of their production to one large customer, the remaining 50% being equally divided between three or four medium-sized customers. Small operators command lower prices for their product: $3.30 to $4.20/kilo. The larger producers command higher prices ranging from $3.90 to $7.75/kilo; the higher prices presumably relate to quality and continuity of supply. Some of the marketing difficulties of smaller producers are because the salmon aquiculture industry in Scotland, unlike that in Norway, did not develop in areas which were closely linked to the traditional fishing industry. There were thus some substantial distribution problems, at least initially in marketing and selling. The prices obtained by small producers operating a 20-tonne salmon farm put them very near to the edge of viability. The returns obtained by small operators without regular clients are low because they must often sell on the London or Manchester fresh fish markets where the bargaining power lies with the purchasers.

The image problem suffered abroad by the Scottish salmon industry is not, as previously thought, related to the lack of evisceration, because this is done at the request of the customer. Rather, the problem results from the Scottish reluctance to bleed live fish. Most producers do bleed the fish; however, some are still hesitant to do so for fear of drawing the attention of the animal rights lobby. More humane ways of bleeding the fish have been investigated, for example stunning the fish by injecting CO into the water prior to bleeding.

In 1986, Scottish salmon production amounted to 10,500 tonnes. In 1987, production is expected to be in the 13,000 to 14,000 tonne range. Although this is below published estimates, it is not because of any disease problems, as is the case in Norway. It is rather due to the sale of Scottish production at an earlier (and smaller) stage than usual, in response to the supply gap in the markets caused by the shortfall in Norwegian production. Markets that were unable to obtain sufficient supplies from Norway fell back on Scottish salmon, which, as a result, fetched very good prices in 1987.

About 50% of Scottish production is sold in the United Kingdom, about 30% in the EEC and 20% in the US. The recent growth of the Scottish industry is mainly attributed to what are considered extremely large markets.

The reverse is true for trout production, which is widely absorbed within the United Kingdom. [n the southern part of that country 3,000 tonnes of trout are produced and in the north about 2,000 tonnes. Most rainbow trout production in the UK is from land-based freshwater aquiculture which, according to HIDB officials, does not have profit margins anywhere near those obtained from salmon aquiculture. This is a consequence of the product's lower market price and the higher operating costs of land-based operations.

D. Planning Control and Conflicts Among User Groups

There is direct competition between those who would use a site for a sea-farm and those who would use it for the mooring of recreational boats. Some of these conflicts have been resolved in the site application process which requires fish farmers to obtain leases from the Crown Estates Commissioners. The lease application is made the object of public consultations which allow concerned parties to present their views.

Also opposing the fish farm industry is the so-called "scenic lobby". Discussions 'have taken place between the main government body (the Countryside Commission) and the local planning authorities to develope guidelines for how farmers can minimize the impact of fish farming on the visual horizon. For example, they are encouraged not to use orange or yellow nets when simple brown nets will do; not to use large yellow buoys when less visible buoys meet safety standards; not to leave garbage strewn about, etc. Planning control for land-based and freshwater operations rests with the

Regional Councils, which control aquiculture development in much the same way as they control other types of industrial development. Sea-based operations are under the control of the Crown Estates Commission, which, beyond a requirement to consult in responding to lease applications, has no formal planning mechanism or guidelines.

Another opposing group is the "conservationist lobby". It is recognized that a fish farm will affect the quality of the water and consequently the other life forms (fish and fowl) using it. The HIDB, in cooperation with other organizations, is funding scientific assessments of the impact of fish farming on the marine environment. Preliminary results show that the impact is quite substantial, especially where a lake is shallow or the water exchange rate is low. They also show that there is a definite impact on seawater in the immediate vicinity of the cages but that this hardly exists beyond a range of 100 metres.

According to HIDB officials, much of the opposition to the increasing number of farms was reactive and not always well founded. The lack of information led the consultative process to the point where it was becoming unmanageable. Studies such as those described above will provide the basis for a more rational public debate. This could be an important lesson for Canadian aquiculture development: basic information on the potential impact of aquiculture development is necessary and any consultative process should strike a balance between the various interests of all concerned. Generally speaking, the density of the farm is the factor that seems to trigger most public opposition to fish farming.

When applying for a Crown Estates lease, an applicant states the proposed number of cages and the total of tonnage this represents. The Crown Estates Commissioners will approve or disapprove of the application according to information presented by the applicant and other concerned parties. As far as the Crown Estates Commissioners are concerned this is the end of the matter, unless there is a transgression of the licensing conditions. Should diseases occur, the matter falls under the authority of the Department of Agriculture and Fisheries. The fish farmer is obligated to report the disease to the Department, as must be done for diseases in the agriculture industry, and the Department will respond with an order prohibiting the sale and distribution of the diseased fish.

The Department of Agriculture and Fisheries is apparently not involved in the licensing process beyond receiving a copy of the licence

application in much the same way as other concerned parties. Public institutions such as DAF or HIDB would not respond to such notification unless the history of the applicant warranted it. Apparently there are no regulations which would form the basis for such a response by public authorities to a particular licence application.

In Scotland, unlike British Columbia and the Maritimes, there is no regulation requiring a minimum distance between farms. The Crown Estates Commissioners recently proposed a guideline of between one to five miles but this was not accepted, mainly because of the many instances in which existing fish farms would have been found in violation. Though it is thought that at some point there will have to be consensus on the minimal distance, some believe that no specific requirement will work (at least with respect to fish health) as too many variables must be taken into account, such as the water currents and exchange in any particular location. The Shetland Islands Regional Council, which regulates aquiculture on a legal basis specific to its own area, has, however, developed its own guidelines. It imposes a minimum distance of 500 metres between farms owned by the same company and a minimum distance of 1,000 metres between farms operated by different owners. Arrangements are possible between operators using smelts from the same source because this removes one of the reasons for having the increased minimum distance between farms.

The issues of planning control mechanisms (discussed above) and fish health (discussed in the next section) illustrate the problems that can develop in the absence of clearly defined jurisdiction between different levels of government or between the same levels of government operating in different geographical areas. This is a good argument in favour of uniform regulations for aquiculture development across Canada.

E. Genetic Transfers and Disease Problems

In Scotland, the broodstock used in one area is not necessarily native to that area. Atlantic salmon are river-specific genetically speaking and the result of salmon escaping from a farm could be the mixing of different strains of Atlantic salmon. For example, much of the tonnage farmed in the Shetland Islands is actually based on smelts from Southwest Scotland.

However, there is not much concern about these genetic effects, at least in the Shetland Islands, which lost their native salmon stocks long ago. In other areas, there is a perception that this is a possible problem, but the

situation has been out of control for a long time since Scottish anglers have had a long history of engaging in genetic "interference" by transferring stocks from one river to another for enhancement purposes.

The DAF does not address the question of genetics during the licensing application by asking whether the broodstock or smelts to be used are native to the area. Nor does there seem to be much concern about the spreading of diseases by the transfer of smelts from one area to another. It was noted that the possibility of producers using diseased smelts increases when there is a shortage of smolts (Norway is a case in point).

In Canada, there is substantial concern about potential genetic transfers or even the possibility of spreading diseases. Salmon stocks in some rivers have a history of being affected by certain diseases while there are other rivers where these diseases have never been detected. It is best to avoid locating a farm containing potentially diseased stocks at the mouth of a river which supports runs of disease-free stock.

There is an uneven application of fish health regulations in the United Kingdom. As a result, some diseases have spread from one part of the country to another. In Canada, the federal government has retained responsibility for fish health protection throughout the whole country. Uniform application of all regulations pertaining to fish health across Canada will contribute to avoiding situations such as those that have occurred in the United Kingdom. There may also be a case for extending federal *Fish Health Protection Regulations* under the *Fisheries Act so* that they would apply intra-provincially.

F. Veterinary Services

Scotland has unresolved problems in this area. There are two sources of veterinary advice in Scotland. One is the Department of Agriculture and Fisheries based at the Marine Laboratory in Aberdeen, where there is a Fish Diseases Unit. The other is the University of Stirling, which has built up a whole Department of Aquiculture from a section formerly called the Department of Aquatic Macro-biology. There is controversy as to the preeminence of either organisation in the area of fish health and some people have tended to use the services of one organization rather than the other.

Progress was achieved when it was realized that aquiculture offered substantial returns and that there was money to be made from it. Thus individual veterinarians upgraded their skills in the area of fish health, and young veterinarians started specializing in that subject; now, most veterinary practices in Scotland have veterinarians specializing in fish diseases. The University of Stirling in Scotland and the Royal Veterinary College in England have put more emphasis on fish health in their academic programs. There is a general feeling, however, that a lag exists between the level of service available and that which is required to meet the industry's rapid growth. It is not known whether the industry has itself engaged in any activities to stimulate interest in fish veterinary medicine, such as setting up scholarships; such a proposal might be of interest in Canada.

Regarding the use of antibiotics and chemicals in the preventive aspects of veterinary medicine in the Scottish salmon farming industry, it is thought that the lack of knowledge leads to excessive use of drugs and medications.

It is believed that although Norway had less expertise in fish veterinary medicine than Scotland, the Norwegian industry avoided large-scale crop losses because it comprises many small farms, so that authorities were able to contain problems as they occurred.

G. Lobster Culture

Advances in this area have been used to carry out stock enhancement programs but are not yet sufficient to permit lobster farming. It is mainly the the aggressive behaviour of the lobster which prevents farming from being a viable operation.

H. Norwegian Foreign Investment in Scottish Aquiculture

There is a substantial amount of Norwegian investment in Scottish aquiculture and the HIDB is criticized for supporting this. In the Shetland Islands, where a different legal framework applies, the Regional Council will not support applications for aquiculture licences other than from local residents, much as is done in Norway itself. Norwegians investors are attracted to Scotland because of the lack of regulations on farm size and as a result, Norwegian investment plans are often grandiose. Such investment plans are treated cautiously, however, and lease applications are often granted

only with a reduction in the planned size of operation. In addition, investigations on a Norwegian applicant's record in his home country are carried out.

There may be a lesson for Canada, since a few large failures in the beginnings of an industry can cause risk capital to dry up quickly and constrain subsequent development.

I. Relative Importance of Fish Farming and the Commercial Fishery

There are apparently very few fishermen involved in the fish farming business. This is consistent with the observation that fish farming in Scotland developed in areas that were not linked to the traditional fishing industry. To put Scottish fish farming in perspective, it is expected that within 12 to 18 months, it will be producing tonnage in the area of 25,000 tonnes of salmon. The farm gate value of this production will represent 50% of the landed value of the total catch of the traditional fishing industry in Scotland, which in itself accounts for half the weight and value of landings in the whole of the United Kingdom.

J. Survival Rates in Salmon Aquiculture

Figures of 350 to 500 smelts per tonne or 7,000 to 10,000 smelts per 20-tonne unit imply a survival rate of about 70 to 50%, assuming the salmon are sold at an average weight of 4 kilos each. Although this seems a low survival rate, it can be put in the following perspective.

The mortality rate in the grow-out stage can be quite low, certainly below 5%. However, there has traditionally been a mortality rate as high at 50% in the transfer stage since smelts cannot acclimatize to the saline water if they are transferred too early, The layman may think that there would be cost savings from lowering that mortality rate; however, the industry believes that this mortality rate is inevitable since the smelt producer must send out his smelts when the majority of them have smoltified (i.e. are ready for transfer to seawater), To date it has not been worthwhile to try to increase the survival rate during the transfer stage since, as pointed out by HIDB officials, these opportunity costs are easily absorbed as long as both the smelt producers and the farmers are making substantial returns.

II-SCOTTISH MINISTRY OF AGRICULTURE AND FISHERIES, MARINE LABORATORY: (ABERDEEN)

A. Statistical Overview of Salmonid Farming in Scotland

Total salmonid aquiculture production in Scotland was 12,654 tonnes in 1986, up from 9,177 in 1985. However, nearly 100% of this production increase was from salmon farming. The production of rainbow trout showed only a marginal increase in 1986. The relative importance of trout and salmon farming in Scotland is evident when one considers that 80% (or 10,340 tonnes) of total salmonid aquiculture is salmon production, which, as in Norway, is the prime focus of aquiculture, although some progress is being made in shellfish aquiculture. About 150 shellfish aquiculture leases have been issued to date in Scotland, although not all of these are operational.

[t is expected that Scottish salmon production will be in the order of 45,000 tonnes in 1989 and 63,000 tonnes in 1990. These projections are based on the most recent estimates of the number of smelts expected to be produced and placed in grow-out facilities in 1987 and 1988 respectively. Thus, in a very few years, salmon aquiculture in Scotland will reach a production level equivalent to that of Norway.

The following statistics illustrate the rapid expansion of the Scottish industry. There were 10 trout farms in 1976 compared with 115 in 1986; salmon farms increased from 6 in 1976 to 170 in 1986. The 1986 figures include both active and inactive sites (i.e. farm sites soon to be in production). There were 13 inactive sites for trout farms and 51 for salmon farms.

Trout farming started in the early 1970s, grew quite rapidly and then levelled off because it did not succeed beyond the domestic market. The salmon industry also started in the early 1970s. It had a much longer gestation period, as evidenced by the fact that it only started to grow spectacularly in the following decade.

The number of salmon farms overtook the number of trout farms in the early 1980s, presumably under the impetus of the HIDB's program to facilitate the entry of small producers into salmon aquiculture which offered better growth potential.

Employment in the Scottish salmonid aquiculture industry has increased from 150 jobs in 1979 to 1,244 jobs in 1986. Of course, some of this employment (about 38% or 482 jobs) is on a part-time basis. Direct employment in the salmonid aquiculture industry can be broken down along the following lines: 223 jobs in trout rearing, 288 jobs in salmon hatcheries and 733 jobs in salmon rearing.

The beginnings of the salmon aquiculture industry were initially associated with big firms. However, the industry's development subsequently followed a different pattern as evidenced by the following data.

In 1986 there were about 113 companies operating 168 sites of which 117 were active: i.e., they contributed to 1986 production figures. Of the active farm sites, seven were facilities producing on average over 440 tonnes each annually. These seven sites accounted for 30% (or 3,100 tonnes) of the 1986 production. There were also in 1986 about 25 sites whose sizes ranged from 101 to 300 tonnes. These medium size sites contributed to 48% of the 1986 production of farmed salmon. The remaining 85 farm sites ranged anywhere in size from under 10 tonnes to 100 tonnes annually although the majority of them were in the 10 to 25-tonne range. These smaller production facilities accounted for 24% of production in 1986. About 5 to 7% of the salmon production is done in "pump-ashore" systems (i.e. land-based systems) located quite close to the shoreline.

Trout production in Scotland is generally carried out on a much smaller scale than that of salmon: trout rearing facilities produced an average of 30 tonnes each in 1986. The majority of operations were, however, in the 10 to 25-tonne range with only few operations (about eight) producing over 100 tonnes. Most of the trout rearing (close to 90% of production) is done in freshwater facilities, unlike the Norwegian "sea trout".

B. Other Relevant Facts about Scottish Aquiculture

Many of the people involved in fish farming are conservation-minded, which makes them hesitant to take the necessary measures to deal with the problem of the predator seal, which is apparently quite significant in Scotland.

Nearly all the sheltered sites along the Scottish coastline are leased and are either in production or soon to be. This has generated some conflict in

the **absence of set regulations** concerning the minimum distance between farms. The technology exists for the establishment of sea farms in more exposed waters in the near and off-shore waters, but it is unknown whether the industry is generating sufficient profits to make this option viable.

As an indication of the industry's viability, this is the first year in which the Crown Estates Commissioners will be generating significant revenues in the form of rents from the aquiculture industry. Revenues in 1987 are expected to be in the order of $2.3 million and revenues in the following year are expected to go even higher. The rent charged by Crown Estates Commissioners is a percentage of the gross farm revenues and there can be lower rents for farms located in the more isolated areas, to compensate for higher transport costs. These revenues will largely go towards covering the additional operational costs incurred by the Crown Estates Commissioners in administering the licensing process. Ten to fifteen per cent of these revenues will, however, go into R&D, although this will not at this moment be directed at further development of the near and off-shore technology.

The foregoing is relevant to the Canadian situation in that the licensing and regulatory process involved in the development of this new industry in Canada implies possibly significant administrative costs. The question of charging rents for leases and cost-recovery of expenses incurred in processing lease applications could become important.

C. Diseases: The Spread of Furunculosis from Scotland to Norway

The spread of furunculosis from Scotland to Norway in 1985 was caused by a relaxation of the import requirements under the Norwegian fish health protection regulations. The Norwegian government was being subjected to increasing pressure from Norwegian farmers who were faced with severe smelt shortages. It therefore allowed fish farmers to import salmon eggs from a hatchery with a history of the disease, against the better advice of Scottish authorities, which apparently could not legally prevent their exportation.

The *Diseases of Fish Act*, dating from 1937 was amended in 1983 to make further provisions for preventing the spread of diseases among fish, including shellfish and fish bred or reared in the course of fish farming. This Act covers such areas as the importation of live salmon, infected waters, and

related precautions as well as the power to require the disclosure of information and measures for the enforcement of the Act's provisions.

D. Other Aquiculture Research

The Marine Laboratory at Aberdeen also conducts research on shellfish, including oyster and scallop. Both Spanish-style long lining-rafting and sea bed cultivation techniques are employed. In Scotland, production in 1986 was in the order of 680 tonnes, worth $700,000 and 150 shellfish farms are registered. Research is carried out on new species such as the Queen scallop, and is also carried out on the control of diseases and parasites. Surplus shellstock from hatcheries is released as a means of enhancing wildstock populations.

Research is also conducted on the potential contaminating effect of substances used in aquiculture operations. Experiments have demonstrated that tributyltin (TBT) antifouling compounds bioaccumulate in both salmonids and shellfish. In Scotland, mechanized net cleaning techniques are now used instead of chemical antifoulant agents.

III—FISH FEED PLANTS: (INVERNESS AND EDINBURGH)

As part of its trip to Scotland, the Committee also visited two compounded dry feed manufacturing plants: one owned by British Petroleum and the other by Ewes Limited, a firm which is part of a Swedish-owned conglomerate and which is also active in British Columbia.

Dry feed is the most common type of feed used in the Scottish aquiculture industry for a number of reasons, the main one being the lack of capelin and herring for salmon feed. The Scottish fishing industry is resource-short and the fishing and aquiculture industries are not in the same areas. As a result, dry feed in Scotland is manufactured mostly with imported (herring) fish meal. Dry feeds are so called because the moisture is extracted from the pellets. This involves substantial energy costs, which make dry feeds more expensive. However, dry feeds have a number of advantages: they have a better conversion ratio and they can be stored longer (up to 6 months) depending on the amount of preservatives included. Also dry feeds are more easily used in automated feeding machines, which will reduce farm labour costs but increase capital costs.

The feed manufacturers visited by the Committee seemed to employ a relatively standard mixture dictated by what is currently known about the nutritional requirements of farmed fish: 46% protein, 1170 ash or calcium, 15% oil and 1.5% fibre. In addition the feed contains permitted anti-oxydants, emulsifiers, stabilisers and a binder, as well as a colourant. Medication may be added by the manufacturer when requested by the farmer and prescribed by a veterinarian. However, medicated feed may not be fed to the fish within 30 days of slaughter.

Moist feed, which is more likely to be used in Canada (especially on the east coast), is manufactured with prime quality round head-on herring which is ground and used as the source of protein. It is also combined with other products by using binders. The lower energy costs of manufacturing moist feed, make its use very advantageous when ample supplies of fish are available nearby.

The feed prices for salmon in the grow-out stage at the manufacturing plants visited by the Committee ranged from $1.30 to $1.40/kilo. The price variation depends on the additives, such as vitamins, pigmentation agents etc. According to price lists, it would appear that Canadian salmon growers may have lower feed costs than their Scottish counterparts.

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Royal Norwegian Ministry of Fisheries. *Act of 14 June* 198S (*# 68) relating to the Breeding of Fish, Shellfish, etc. 20* pages.

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APPENDIX

List of Organizations and people visited:

FROM NORWAY:

Directorate General of Fisheries Aquiculture Division: (Bergen)

Mr. Torben Foss, Assistant Director General;

Mr. Odd Nakken, Director of the Institute of Marine Research

Mr. Per Mietle, Director General, Head of the Department of Fisheries Economics;

Mr. Arthur Helm, Director General, Head of the Department of Legal Matters and Fishing Activity;

Mr. Heine Blokhus, Director General, Head of the Department of Fish Quality Control;

Mr. Sigbjorn Lomelde, Head of the Advisory and Information Division;

Mr. Tore Nilsson, Head of the Aquiculture Division.

Mowi's Fish Farm Company Ltd.: (Bergen)

Ms. Bodil Richardsen, Marketing Manager.

Sea Farm Company Ltd: (Bergen)

Mr. Alfred Bringsvor, Marketing Officer.

Royal Norwegian Council for Scientific and Industrial Research (Trondheim)

Mr. Idar Schei, Program Director (Aquiculture);

Mr. Leif Jorgensen, Aquiculture research group.

Fish Farmers Sales Organization: (Trondheim)

Mr. Odd Ustad, Public Affairs Department Manager.

Royal Norwegian Ministry of Fisheries: (Oslo)

Mr. Magnor Nerheim, Deputy Director General, Department of Processing and Sales;

Ms. Kari Bjorbaek, Head, Aquiculture Division.

Norwegian Bank Representatives: (Oslo)

Mr. Per Arne Flakke, Manager—FOKUS BANK

Mr. Jo Stokke, Lawyer-CHRISTIANIA BANK

Mr. Einar Irgens, Lawyer

Mr. Bjarte Tunold, Manager

Mr. Jan Loken, Manager—BERGEN BANK

Mr. Tore Blikom, Manager—INDUSTRY FUND

Institute of Aquiculture Research: (Oslo)

Dr. Magny Thomassen, Research Scientist

Mr. Morten Rye, Research Assistant (Genetics/Breeding).

Export Council of Norway: (Oslo)

Mr. Sverre Lindtvedt, Director

Mr. Riborg Ericksen, Regional Director

Mr. Morten Nordvoll, Market Advisor

Norwegian Parliamentary Maritime and Fisheries Committee: (Oslo)

Mr. Hans Svendsgard, Chairman

Mrs. Nymo Synmore, Member

Mrs. Mary Eide, Member

Mr. Peter Angelsen, Member

Mr. Rolf Bendiksen, Member

Mrs. Ranveig Froiland, Member

Mr. Nils Golten, Member

Mrs. Britt Harkestad, Member

Mr. Oddvar Majala, Member

Mr. Runar Jensen, Secretary

FROM SCOTLAND:

Highlands and Islands Development Board: (Inverness)

Mr. J.A. Macaskill, Secretary

Mr. Jim Lindsay, Head of Special Policy Unit

Mr. Archibald E. McCunn, Board Member

B.P. Nutrition Company Ltd.: (Invergordon)

Mr. Mike Oakes, Mill Manager

The Ministry of Agriculture and Fisheries for Scotland: (Aberdeen)

Dr. A.D. Hawkins, Director

Mr. David MacLennan, Deputy Director

Mr. Alan Munro, Head, Health Fish Cultivation Group

Mr. Ray Johnston, Head, Triploid Research

Dr. Ian Davies, Head, Tributyltin Investigation

Mr. James Mason, Head, Shellfish Cultivation

Ewes Company Limited: (Westfield, Bathgate)

Mr. Hans Ekerot, Manager, Director.

Note: The foregoing Report was printed in Issue No. 25 of the Minutes of Proceedings and Evidence of the Standing Committee on Fisheries and Oceans.

A copy of the relevant Minutes of proceedings and Evidence of the Standing Committee on Fisheries and Oceans (*Issues* Nos. *21*, 24, 25, 39 *and* ***40 which includes this report)*** is tabled.

Respectfully submitted,

GERALD COMEAU

Chairman

MINUTES OF PROCEEDINGS

[Text]

TUESDAY, JUNE 7, 1988
(57)

The Standing Committee on Fisheries and Oceans met, *in camera,* at 9:20 o'clock a.m., this day, in Room 208 West Block, the Acting Chairman, Ted Schellenberg, presiding.

Members** of the **Committee present: George Henderson, Jim Manly, Charles-Eugene Marin, Ted Schellenberg.

Acting Member present: Darryl Gray for Morrissey Johnson.

***In** attendance: From the Library **of** Parliament:* Pierre Touchette, Researcher. *From the Department of Fisheries and Oceans:* Robert H. Cook, Director of St-Andrews Biological Station.

In accordance with its mandate under Standing Order 96(2), the Committee commenced consideration of the draft report on Aquiculture in Canada.

At 11:25 o'clock a.m., the Committee adjourned to the call of the Chair.

TUESDAY, JUNE **14, 1988**
(58)

The Standing Committee on Fisheries and Oceans met, ***in** camera,* at 7:05 o'clock p.m., this day, in Room 307 West Block, the Chairman, Gérald Comeau, presiding.

Members of the Committee present: Gérald Comeau, George Henderson, Jim Manly, Charles-Eugene Marin, Ted Schellenberg.

***In** attendance: From the Library of Parliament:* Pierre Touchette, Researcher. *From the Department of Fisheries and Oceans:* Robert H. Cook, Director of St-Andrews Biological Station.

In accordance with its mandate under Standing Order 96(2), the Committee resumed consideration of the draft report on Aquiculture in Canada.

At 10:00 o'clock p.m., the Committee adjourned to the call of the Chair.

THURSDAY, JUNE 16, 1988
(59)

The Standing Committee on Fisheries and Oceans met, *in camera,* at 8:05 o'clock a.m., this day, in Room 208 West Block, the Chairman, Gérald Comeau, presiding.

Members** of the **Committee present: Gerald Comeau, Jim Manly, Charles-Eugene Marin, Ted Schellenberg.

***In** attendance: From the Library of Parliament:* Pierre Touchette, Researcher. *From the Department of Fisheries and Oceans:* Robert H. Cook, Director of St-Andrews Biological Station.

In accordance with its mandate under Standing Order 96(2), the Committee resumed consideration of the draft report on Aquiculture in Canada.

At 10:50 o'clock a.m., the Committee adjourned to the call of the Chair.

TUESDAY, JUNE 21, 1988
(60)

The Standing Committee on Fisheries and Oceans met, *in camera,* at 8:23 o'clock a.m., this day, in Room 253-D, the Chairman, Gérald Comeau, presiding.

***Members** of the Committee present;* Gerald Comeau, George Henderson, Jim Manly, Charles-Eugene Marin, Ted Schellenberg.

***In** attendance: From the Library of Parliament:* Pierre Touchette, Researcher.

In accordance with its mandate under Standing Order 96(2), the Committee resumed consideration of the draft report on Aquiculture in Canada.

On motion of George Henderson, it was agreed,—That the draft report, as amended, be adopted as the Committee's Fourth Report to the House and that the Chairman be instructed to present the report to the House.

On motion of Jim Manly, it was agreed,—That the Chairman be authorized to make those changes as instructed by the Committee during its meeting today, and any editorial changes as required in consultation with the Committee researchers.

On motion of Ted Schellenberg, it was agreed,—That the Committee print 4,000 copies of its Fourth Report to the House in tumble bilingual format with a distinctive cover.

On motion of Ted Schellenberg, it was agreed,—That the Committee's trip report to Europe be printed as Appendix B to the Fourth Report.

On motion of Jim Manly, it was agreed,—That the transcripts of in camera meetings be kept as confidential documents by the staff of the Committee for a period of three months after the meetings, after which the transcripts will be disposed of.

At 11:00 o'clock a.m., the Committee adjourned to the call of the Chair.

Jacques Lahaie

Clerk of the Committee