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16. Abstract (Limit: 200 words)

World production of pen-farmed salmon doubled from 33,800 metric tons (t) in 1984 to 71,800 t in 1986. Approximately 90 percent of the world's production of farmed salmon in 1986 came from Norway, the United Kingdom, and Japan. Ireland, Chile, and the Faroe Islands contributed about 6 percent of the world's salmon production. Norway's production of farmed Atlantic salmon (Salmo salar) has shown the most dramatic growth, increasing from 4,100 t in 1980 to 45,600 t in 1986 a ten-fold increase in just 6 years, accounting for about 75 percent of the world's production of farmed Atlantic salmon. The key to future world production of farmed salmon is Norway, which could produce as much as 100,000 t of farmed Atlantic salmon by 1990. The United Kingdom replaced Japan as the second largest producer of farmed salmon in 1986. Production of pen-farmed salmon in Ireland, Iceland, the Faroe Islands, and Canada is expanding rapidly. The Foreign Fisheries Analysis Branch of the National Marine Fisheries Service estimates that the production of farmed salmon will exceed 200,000 t by 1990. Future production, however, will depend on economic and environmental conditions, disease control, the availability of smolts and feed, and consumer demand.

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WORLD SALMON AQUACULTURE, 1986-1987

World production of pen-farmed salmon 1/ doubled from 33,800 metric tons (t) in 1984 to 71,800 t in 1986 (figure 1 and appendix A). The Foreign Fisheries Analysis Branch estimates that the production of farmed salmon will exceed 200,000 t by 1990 (appendix B). Future production, however, will depend on economic and environmental conditions, disease control, the availability of smolts and feed, and consumer demand.

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I. OVERVIEW:

During 1986, approximately 90 percent of the world's production of farmed salmon came from Norway, the United Kingdom (U.K.), and Japan. While Ireland, Chile, and the Faroe Islands contributed about 6 percent of the world's production of 71,800 tons. Norway's production of farmed Atlantic salmon (Salmo salar) has shown the most dramatic growth, increasing from 4,100 t in 1980 to 45,600 t in 1986, a ten-fold increase in just 6 years, accounting for about 75 percent of the world's production of farmed Atlantic salmon. The key to future world production of farmed salmon is Norway, which could produce as much as 100,000 t of farmed Atlantic salmon by 1990. The United Kingdom replaced Japan as the second largest producer of farmed salmon in 1986. Production of pen-farmed salmon in Ireland, Iceland, the Faroe Islands, and Canada is expanding rapidly.

1/ Salmon are "farmed" by two methods. Cage culture involves rearing salmon in enclosures until they are ready for harvesting. The enclosures may be pens, cages, or tanks. Ocean ranching involves releasing immature salmon into the wild and harvesting the fish at sea or upon their return as mature adults ready for spawning. This report is primarily concerned with cage culture, where the harvest is predictable and salmon may be harvested according to market demands.

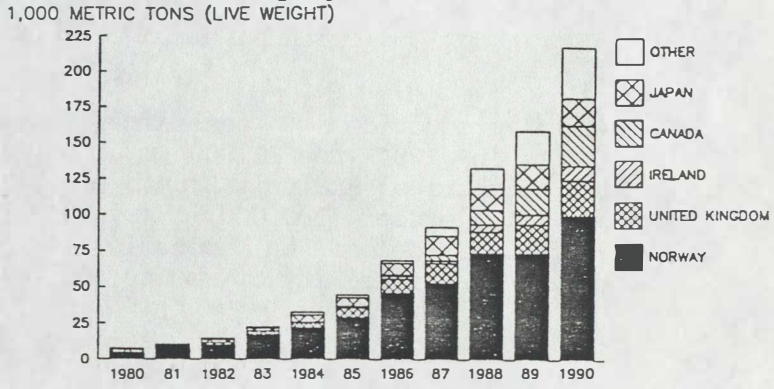
Farmed salmon production has doubled every 2 years between 1980 and 1986. If this trend continues, farmed salmon production will exceed 200,000 t by 1990 (figure 1 and appendix A and B).

Production of farmed Atlantic salmon has shown dramatic growth since 1980 as compared with production of various Pacific salmon species; production of Atlantic salmon reached 60,000 t in 1986 versus 11,700 t for the Pacific species. By 1990, according to present trends, it is possible that world production of Atlantic salmon could exceed 160,000 t while Pacific salmon production could exceed 65,000 tons (figure 2 and appendix C).

Salmon aquaculture in Pacific regions will include Atlantic salmon and several species of Pacific salmon. Currently, farms are using primarily coho salmon (Oncorhynchus kisutch) and chum salmon (O. keta), but other species are being studied for use in future culture projects.

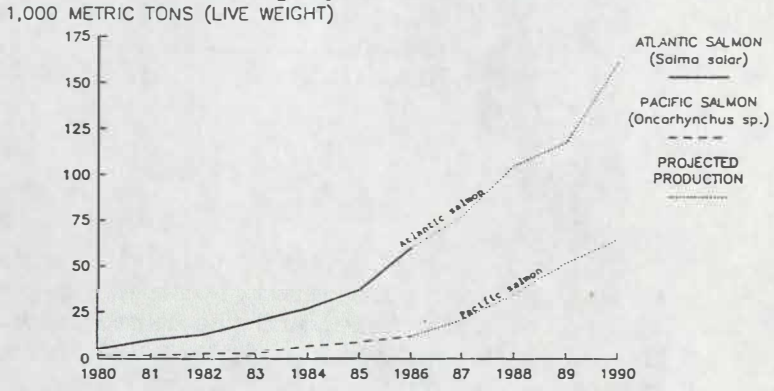
During 1986, nearly 10 percent of the world's salmon supply came from salmon farms. By 1990, it is possible that 20 percent of all salmon could be farm-raised. Since 1980, the U.S. harvest of wild salmon has fluctuated between 275,000 t and 330,000 tons. If present U.S. catch and world production trends are maintained, it is possible that world salmon production might exceed 50 percent of U.S. landings of wild salmon by 1990 (figure 3 and appendix D).

Figure 1.--WORLD. Farmed salmon production, by major producing countries, 1980-1986, with projections to 1990.



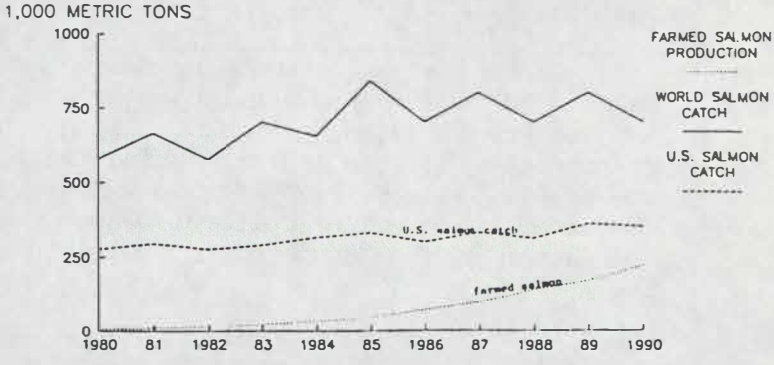
SOURCES: U.S. Embassy reports and various fishing industry publications.

Figure 2. --WORLD. Farmed salmon production, by species, 1980 to 1986 with projections to 1990.



SOURCES: U.S. Embassy reports and various fishing industry publications.

Figure 3. -- WORLD. Farmed salmon production versus U.S. and world salmon catch, 1980-1985, with projections to 1990.



SOURCE: FAO, Yearbook of Fishery Statistics, U.S. Embassy reports, and NMFS estimates.

II. NORWAY:

Norway is the world's most important producer of farmed-raised salmon, and is expected to remain in that position through 1990, when it could supply about half the world's farmed salmon. Norway's production of farmed Atlantic salmon increased from 170 t in 1973 to 45,675 t in 1986 (appendix E). In late 1986 and early 1987, approximately 300 out of 690 salmon farms were infected with a coldwater vibriosis (Vibrio salmonicida) commonly called "Hitra disease" (named for the Norwegian island where the disease first appeared in 1979). According to preliminary estimates, the disease resulted in the mortality or premature harvesting of 8,000 t to 10,000 t of salmon. As a result, it is likely that total production will be closer to 50,000 t in 1987, than the 53,000 t originally estimated. There are no official Norwegian estimates for 1990, but Ministry of Fisheries officials believe production will exceed 100,000 tons. Actual output will depend on several important factors, including availability of smolts, effective disease control, the ability to lower costs in the face of the declining value of the U.S. dollar, and Norway's ability to meet growing competition from salmon farmers in Scotland, Canada, Ireland, and Chile. Additionally, in order to significantly exceed 100,000 t, the Government of Norway will have to issue new licenses.

Norway's spectacular progress as a pioneer in the production of farmed Atlantic salmon is the result of an abundance of natural resources (protected fjords and ideal temperatures), a skilled labor pool, an excellent transportation system, government support, and close industry cooperation in all phases of salmon aquaculture. A decline in Norway's fisheries catch in the early 1970s, coupled with abundant revenues from offshore oil production, set the stage for the development of the salmon farming industry. To help farmers in depressed rural areas, the Government of Norway established a policy limiting salmon farms to 8,000 cubic meters of water, sufficient to produce 150 to 250 t of salmon annually. This policy also led to the development of specialists in the manufacture of feed, the harvesting, packing, transportation, and marketing of salmon. The policy favoring small-scale producers has led large-scale producers to acquire small units or to look overseas for investment opportunities.

An important constraint to the growth of salmon farming in Norway during the early 1980s, was the inability of local firms to supply adequate numbers of salmon smolts. Initially, the answer was to import salmon smolts for stocking local farms. In 1985, the problem grew worse when diseased smolts imported from Scotland infected Norwegian fish farms. The situation pointed out the need for Norway to expand domestic smolt production. As a result, the Government of Norway imposed strict regulations on the importation of salmon smolts and encouraged the development of local smolt production by making it easier to obtain licenses for smolt production. Official regulations allow smolt producers to raise one million smolt per year. As a result, significant strides have been made in the past 2 years. In 1985 there were 322 firms licensed to rear 41 million smolts. By January 1987 there were 565 firms licensed to produce 153 million smolts. However, because of production problems and because many fish farmers are new to the business, output is not expected to exceed 30 to 40 percent of licensed capacity. Some Norwegian fish farmers have recently expressed concern that the rapid rate of smolt production might lead to an oversupply of salmon by 1988.

Most of Norway's farm-raised salmon is exported. Farmed salmon exports increased from 24,000 t worth $152 million in 1985 to 39,000 t worth nearly $230 million in 1986. During 1986, Norway exported 9,200 t of farmed salmon worth $56 million to the United States, or about one-quarter of the country's total farmed salmon exports during that year. France, the Federal Republic of Germany (FRG), and Denmark were other important customers for Norwegian salmon (table 1).

Table 1.—Norway. Exports of farmed salmon, fresh or frozen, to main markets, by country and quantity, 1982-1986.

Country	1982	1983	1984	1985	1986
			Metric tons*		
France	2,710	4,298	4,374	3,828	9,904
United States	762	2,486	4,700	6,473	9,277
Denmark	1,240	1,957	2,419	2,494	5,462
FRG	1,850	2,466	2,625	2,819	4,671
United Kingdom	930	1,381	1,716	1,296	1,917
Sweden	590	824	943	1,023	1,916
Spain	453	NA	697	1,108	1,648
Belgium	558	NA	713	863	1,390
Japan	-	134	278	NA	771
Switzerland	504	NA	524	NA	725
Netherlands	182	NA	291	NA	684
Other	222	NA	192	2,330	1,539
Total	9,414	15,370	19,472	21,443	39,904

*Live weight.
Source: "Fish Facts", U.S..Embassy, Oslo (1982-1985), and Report to the Norwegian Parliament, Number 65, Norwegian Ministry of Fisheries, 1987 (for 1986).

Fish farmers are eligible for loans and other benefits from various Government of Norway agencies. The largest source of aquaculture funds are district development banks which offer loans, loan guarantees, and investment grants. These banks are part of the Government's long-standing policy of supporting development in isolated regions where depopulation is a major concern. In 1984 (latest available data), $71 million was made available by the various district development banks. In addition, commercial loans were made by the State Industry Fund ($1.1 million), the State Fisheries Bank ($0.9 million), the State Industry Bank ($0.8 million), and the State Agriculture Bank and Development Fund ($0.09 million), as well as private banks and credit companies.

The Government of Norway also supports the fish farming community by providing scientific research, training, extension services, technical, veterinary, and breeding research conducted at a number of Norwegian universities or colleges. The rapid development of a vaccine to fight Hitra disease by the Foundation of Applied Research at the University of Tromsoe is an example of close cooperation between Norwegian universities and the fish farming community.

Future directions for Norwegian salmon farming include the possibility of increased salmon ranching -- where smolts are released into the sea to feed and return to their native streams as mature adults to spawn. The high cost of feed in Norway is making salmon ranching more attractive, despite problems of uncertain returns. Norwegian researchers are also examining the possibility of using large oil tankers to transport live salmon to distant markets without the high costs of commercial air cargo. Researchers apparently have been able to overcome some of the problems involved in shipping salmon by ship, including the tendency of some fish to get "seasick" while being transported. Research is also being directed at the use of electrical currents or sounds to control the movement of farmed salmon, or keeping salmon inside "electric fences underwater" which will make much larger areas available for salmon production. Once the technical problems are resolved, there will, however, remain many social and legal issues to be settled. Norwegian scientists are also studying how to attract the fish to feed at the sound of noise. Greater efforts are being placed on increasing yields in closed systems through the application of new technology; most salmon farms are limited, by law, to 8,000 cubic meters of water. Because of improved technology, these same farms can now produce as much as 200 to 300 t of fish per 8,000 cubic meters of water, an increase of 50 t per farm. This high-density raising of fish, however, makes many farms vulnerable to fish diseases and many farms were quickly infected by Hitra disease in late 1986 and early 1987. Continued research into fish diseases and on the effect of fish farming on the environment will continue to be important areas of studies in the next few years. Finally, Norwegian fish farmers and companies have been investing overseas for quite some time where prohibitions on establishing large farms do not exist.

III.i UNITED KINGDOM:i

The United Kingdom (U.K.) ranks second, after Norway, as the world'si most important source of farmed salmon. The U.K. salmon farming industry is centered in western Scotland and in the Shetland and Orkney Islands where clean water, isolation, and protected coastal inlets offer ideal conditions for salmon aquaculture.

Salmon farming in Scotland was begun by Unilever, the Dutch-English multinational corporation, which established a salmon farm in 1969. Following a period of slow growth, the salmon farming industry expanded rapidly; between 1983 and 1985, the number of companies farming salmon in Scotland doubled from 49 to 104 firms while the number of farms increased from 103 to 194; production increased from 2,500 t to 6,900 t during the same period. In 1986, Scotland's farmed salmon production increased to 10,338 tons (appendix F).

It is likely that Scottish farmed salmon production will reach 25,000 t by 1990, assuming an average growth of 4,000 t per year between 1987 and 1990. Although the outlook for rapid growth of the Scottish salmon farming industry is excellent, some potential limits to growth have begun to surface. Many of the most choice sites have already been developed or reserved. Future expansion will probably have to occur from expansion of existing sites or development in more remote locations, such as in the Shetland Islands where 37 farms produced 1,500 t of salmon in 1986 and where production of 8,000 t is predicted for 1990.

Table 2.--U.K. Fresh or chilled salmon exports, by quantity and value, 1980-1986.

Year	Quantity	Value
	Metric Tons	US$1,000
1980	314	3,500
1981	495	4,186
1982	625	6,008
1983	999	10,089
1984	1,789	18,497
1985	2,942	NA
1986	4,277	NA

Sources: Sea Fish Industry Authority (1983-1985) and Eurostat (EC) trade statistics (1980-82). Note: Exchange rates were: £1 = US$1.30 (1985), US$1.33 (1984), US$1.52 (1983).

Exports of Scottish salmon have nearly doubled in value during the past 3 years. Most of Scotland's fresh or chilled salmon exports stay within the European Community (EC), being shipped primarily to France, the Netherlands, and the FRG. Exports to the United States increased from $0.7 million in 1983 to $3.9 million in 1985 (table 2).

Scotland's estimated smolt production is 15 million for 1987, and smolt production is expected to reach 22 million by 1988 (table 3). Most smolts required by Scottish fish farmers are being produced domestically, but some smolts are still imported from Norway to help improve strains of Scottish salmon. Landcatch Ltd., 50 percent owned by Saga Seafoods A/S of Norway, has imported salmon from Norway to improve their salmon ova, fry, and smolts. Landcatch's production capacity currently exceeds 10.0 million eggs and 1.4 million smolts.

Table 3.—U.K. Production of smolts, 1980-1986 with estimates for 1988.

Year	Quantity
	Million
1980	1.35
1981	1.50
1982	1.70
1983	2.90
1984	3.70
1985	5.60
1986	6.50
1987	15.00
1988	21.70

Source: Morgan, Angus, The Status and Prospects for Aquaculture in the U.K. Chairman of the Marketing Committee of Scottish Salmon Growers Association, Scotland and Fish Farming International, May 1987 (for 1987 and 1988).

BP Nutrition Ltd., which operates a worldwide network of companies involved in fish farming (including T. Skretting A/S of Norway, the Trouw group of Holland, and the Moore-Clark Company of Vancouver, BC, and Laconner, Washington, USA), is currently the largest manufacturer of animal feeds and premixes in the world. This followed the acquisition of Purina Mills Inc. in 1986. Total sales are expected to exceed 200,000 t of feed in 1987. BP Nutrition recently opened a new specialty fish feed mill at Invergordon, Scotland. The mill's present capacity is 30,000-35,000 t of feed (included pelleted salmon and trout feeds), but could easily expand this production to 100,000 t a year.

Salmon farmers in the U.K. are able to benefit from various types of financial support. The U.K. Government, under the Fish Farming (Financial Assistance) Scheme of 1984, is allowed to grant farmers up to 5 percent of the costs of an aquaculture project. Grants may also be given to fish farmers in underdeveloped areas of Scotland under the Industrial Development Act of 1982, the Integrated Development Program for the Western Isles, and through the quasi-governmental Highlands and Islands Development Board (HIDB). The HIDB, an organization designed to encourage economic development in the region, offers grants of up to 30 percent of the cost of a project and will provide loans below commercial rates. Between 1975 and 1984, the HIDB awarded $17 million in grants and $7 million in loans to support aquaculture in Scotland (including trout and shellfish projects). Salmon farmers have also received grants from the EC European Agricultural Guidance and Guarantee Fund (FEOGA), but the amounts are small (less than $130,000 in 1985). These EC grants cover between 25 and 50 percent of the capital costs of a project, and require the national government to provide between 5 and 25 percent of the total cost of the project.

IV. JAPAN:

Salmon propagation is not a new science to Japan. The country began experimenting with chum salmon culture in 1876, and the first national chum hatchery was built in Hokkaido in 1888. Japan's hatchery system expanded rapidly, and by 1978 consisted of 230 hatcheries. In 1986, there were 270 private, 37 national, and 6 prefectural hatcheries operating in Japan.

Japan's salmon culture programs have operated under the Aquatic Resources Conservation Act (No. 313) since 1951. This act mandates that Japan's Ministry of Agriculture, Forestry, and Fisheries administer a national salmon hatchery program to ensure that Japan does not face the salmon shortages experienced during the period from 1920 to 1950, when salmon stocks were overfished. The act provides for subsidies to private hatcheries and requires that salmon fishermen contribute to the national hatchery program. The act has created a national salmon ranching program in Japan, with the fry and returning adult fish belonging to the Japanese Government. Japanese salmon hatcheries (both Government and private) released a total of over 2 billion fry (mostly chum salmon) in 1986.

Although Japan's salmon hatchery program is well established, commercial salmon farming is a relatively new phenomenon. The Nichiro Fisheries Company of Japan began to culture coho, chum, sockeye (O. nerka), chinook (O. tshawytscha), and pink salmon (O. gorbuscha) in 1971 after its salmon factoryship became a victim of a vessel reduction program. Because coho salmon proved to be hardier than the other species, Nichiro began to concentrate only on coho farming in freshwater in 1973. After Nichiro discovered that coho salmon growth was slower in freshwater, the company turned to ocean cage culture in 1975. In 1978, Nichiro produced 450 t of coho salmon with an 80 percent survival rate from smolt to adult. The Federation of Miyagi Fisheries Cooperatives and several large Japanese companies (including Taiyo and Nichimo) have also recently entered into coho salmon farming. Japan's salmon companies contracted out salmon production to about 350 farms in 1986 and plan to have nearly 400 farms in operation by 1987. Japan's coho production is expected to reach 19,000 t by 1990 (appendix G).

In addition to coho salmon farming, the Nichiro company is also commercially farming small quantities of chinook salmon. The company began farming chinook in 1983, and harvested 21 t of chinook salmon in 1986. Nichiro is also experimenting with raising sockeye salmon, but no data is available on the status of these experiments.

Feed production does not appear to be a problem for Japan. Japanese-produced feed for coho salmon consists of moist pellets made from 90 percent fish (sardine, mackerel, and filefish) and 10 percent formula feed (white meal, wheat and bread crumbs, soybean protein, and krill-like mysis).

Although the future of Japan's cultured salmon industry looks promising, there is a major constraint: egg supply. Japan must import all of the salmon eggs used in farming; mostly from the United States. Approximately 20 Japanese firms import and distribute eyed salmon eggs to smolt farms. In 1986, Japan imported 28 million eyed eggs (versus 19 million eggs in 1985, 12 million in 1984, 14 million in 1983, and 8 million in 1982). The only Government stipulation on the import of salmon eggs is that they be certified disease-free by the exporting country. The Japan Fishery Resources Conservation Association also inspects the salmon eggs to prevent possible carriers of a bacterial kidney disease from entering Japan.

The number of smolt farms in Japan is estimated at 200 to 300. Each is operated by a freshwater fish rearing cooperative which may also produce other salmonids, such as cherry salmon (O. masou), "amago" (O. rhodorus), char (Salvelinus pluvius), brook trout (S. fontinalis), and rainbow trout (S. gairdneri) at each facility. Production of coho smolt to the 100 to 300 gram sizes ranges from 2 t to as much as 100 tons. There are no estimates available on the total number of individual smolts produced by all smolt production facilities in Japan.

Fresh farmed coho salmon is a new commodity for Japanese consumers, and it is well accepted by those already accustomed to salmon products. The pen-reared coho must be taken from coastal pens before high summer temperatures begin inflicting mortalities on the crop. Summer also brings competition from other fish products, such as skipjack tuna. Coho salmon not marketed by early summer are often salted for sale in the fall.

There are no programs or regulations designed to promote salmon imports or exports. Japan's overall demand for salmon products (in the 350,000 to 400,000 t range in 1985) greatly exceeds local supplies of salmon (210,000 t in 1985) of which Japanese hatchery production was 168,810 t, farmed coho production was 6,990 t and the highseas catch of wild salmon was 34,318 tons. Farmed salmon may eventually reduce Japan's need to import salmon, the majority from the United States. Currently, domestic salmon farming accounts for only about 2 percent of Japan's total salmon supply.

V. CANADA

A. GENERAL

Canada has a long history of managing commercial and recreational salmon fisheries. Only recently, however, have Canadians become involved in salmon farming. Production has increased from 163 t in 1980 to an estimated 1,000 t in 1986. The potential for rapid growth in the next few years appears excellent: Canadian government officials anticipate a sharp increase in production, which may reach 27,000 t by 1990. Industry sources expect production could exceed 30,000 t by 1990, based on "fish in the water" (appendix H). If this is achieved, Canada will become the third largest producer of farmed salmon in the world.

B. ATLANTIC CANADA

Atlantic Canada's first attempts at salmon farming began in the early 1980s. The first significant development occurred in 1984, when Stolt-Nielson Sea Farm A/S of Bergen, Norway, established a C$2.0 million salmon smolt hatchery at Lake Digdeguash near St. George, New Brunswick. The new company, Sea Farm (New Brunswick), initially expected to produce 500,000 smolts annually by 1986, representing potential production of 1,300 t of adult Atlantic salmon worth C$8.0 million. Sea Farm (New Brunswick) later increased its smolt production capacity to 1 million smolts, constructed a smolt hatchery at Springdale with a capacity for 250,000 smolts, and is in the process of building a third smolt rearing facility at Oromocto Lake. In 1985, about 200 t of Atlantic salmon, worth over C$2.2 million, had been raised in sea cages located in the Bay of Fundy. During that year, 13 additional entrepreneurs began operations. Each farmer received a Canadian Government grant of 30 percent of the project cost (limited to C$30,000 for first-time projects and C$70,000 for established operations). In 1985, Canadian Minister of Fisheries and Oceans, Tom Siddon, announced that the Canadian Government and the Government of New Brunswick were jointly investing C$1.3 million in a Salmonid Demonstration and Development Farm at Lime Kiln Bay, near Black's Harbor, New Brunswick, bringing the total investment to C$2.7 million. The facility was expected to provide commercial fish farmers with scientific and technological information about cage culturing salmon. In 1986, Connors Brothers Ltd. (a major sardine cannery) announced that it was establishing a sea-cage facility at Fair Haven on Deer Island at the site of one of their old herring plants. The old facility was modified to raise salmon eggs for release into sea-cages. Connors Bros. Ltd. and Corey Feeds Ltd. worked together to produce C$2.9 million worth of salmon feed in 1986 at Beaver Harbor. There were reportedly 32 cage sites operated by 26 firms located in New Brunswick during 1986. It is expected that there will be 425 salmon cages in Atlantic Canada in 1987, producing an estimated C$8.0 million worth of farmed salmon. A moratorium on the establishment of new salmon farms on Canada's Atlantic coast was imposed during 1986, limiting the short-term growth of the industry.

C. PACIFIC CANADA

Pacific Canada's salmon farming region is located in the province of British Columbia (B.C.), where the first salmon farm was established in 1972, using surplus eggs obtained from a Canadian Government salmon hatchery. The site operated until 1975, when 4 new farms were established using salmon eggs also obtained from the Government of Canada. Between

1975 and 1984, the industry remained undeveloped, attracting limited interest and producing only small quantities of salmon. During 1984, when there were only 10 salmon farms, Norwegian companies began to seriously invest in the Pacific salmon culture industry. Following Norwegian involvement, the number of salmon farms grew to 36 by 1985, and to approximately 69 salmon farms in 1986 (including 10 with Norwegian investment). B.C. authorities anticipate 125 sites by 1987 and 225 sites by 1988. Most of the sites are located along the Sechelt Peninsula and Vancouver Island, and employ a small staff of 3 or 4 people. These farms are expected to produce 200 to 300 t of salmon per year. Production has increased from 120 t in 1985 to 600 t in 1986 (table 4 and appendix I).

The British Columbia Provincial Government has identified aquaculture as an area for special emphasis. Incentives to establish fish farms have included concessional loans from the Provincial Economic Development Agency of up to C$150,000 as "seed" money, new venture tax relief equivalent to tax incentives offered traditional farmers, and access to the Province's Venture Capital Program which offers a 30 percent tax credit which can be transferred to other corporate activities.

Pacific Canada fish farmers have used some of these funds to raise coho salmon and chinook salmon. Earlier experiments that introduced Atlantic salmon to Pacific waters were generally unsuccessful, although three farms are still reportedly experimenting with Atlantic salmon (most are being raised at Crystal Water Sea Farms under strict quarantine conditions). Initially, production was based on coho salmon raised to "pan size" (250-300 grams), but in 1982, the production of chinook salmon was introduced, as restaurants and supermarkets in Canada and the United States began to ask for larger sized salmon; coho salmon are reportedly easier to raise, but chinook salmon earn higher returns.

Table 4.--Canada. B.C. farmed salmon production, by species, quantity and value, 1980-1986.

Year	Coho		Chinook		Total	
	Metric tons	C$1,000	Metric tons	C$1,000	Metric tons	C$1,000
1980	157	898	-	-	157	898
1981	176	985	-	-	176	985
1982	230	908	43	228	273	1,136
1983	73	350	55	358	128	708
1984	64*	306	43	396	107	702
1985	66*	395	54	425	120	820
1986	400	NA	60	NA	460	NA

*Includes an unspecified amount of pen-reared rainbow trout.i
Source: Fisheries Production Statistics of British Columbia. Annual. Ministry of Environment. Province of British Columbia, 1985, and Fish Farming International, August 1987 (for 1986 data).

B.C.'s salmon farming boom can be traced to the inability of Norwegian investors to develop similar farms in the State of Washington. To the province's benefit, the Norwegians reportedly invested C$9 million in 10 out of the 11 Canadian fish farms which have been established by foreign investors (the other farm was established by U.S. investors).

The B.C. fish farming industry relies on eggs made available from the Canadian Department of Fisheries and Oceans (DFO). Salmon eggs produced in excess of the DFO Salmonid Enhancement Program needs are turned over to hatcheries. In 1986, 30 million eggs were supplied to B.C. fish farmers (table 5); 27 million eggs were of DFO origin and 3 million came from private producers using wild salmon stocks.

Table 5.—Canada. B.C. supply of salmon eggs for salmon farming, by quantity, 1980-1986.

Year	Species			
	Coho	Chinook	Chum/Pink	Total
	1,000 salmon eggs			
1980	6,012	648	25	6,658
1981	2,688	788	80	3,556
1982	2,516	345	151	3,012
1983	1,659	952	-	2,611
1984	2,187	950	-	3,137
1985	NA	NA	NA	NA
1986	NA	NA	NA	30,000

Source: Department of Fisheries and Oceans. Ottawa, Canada.

There is also a rapid growth in local smolt production; there was only one firm able to supply smolts between 1980 and 1983. Between 1984 and 1985, there were two smolt facilities which produced 2.5 million smolts. In 1986, the number of smolt farms increased by three, and smolt production increased to 8.5 million smolts. Most smolts are obtained locally. Atlantic salmon smolts must be imported; imported salmon smolts are subject to "extraordinary" screening to prevent health problems

Prior to the late 1970s, fish feed was imported from Washington state. Since 1978, however, B.C. feed producers have been supplying their own salmon farmers with feed. By 1984, B.C. manufacturers produced 410 t (90 percent was from M&H Feeds Inc. of Surrey, B.C.) while the United States supplied 1,000 t of fish feed. By June, 1986, there were six fish feed producers serving the B.C. salmon aquaculture industry.

The marketing strategy adopted by B.C. salmon farmers focuses on uniform size, quality, and the availability of cultured salmon when wild salmon are not available. Once consumers become "hooked" on these fish, the B.C. Salmon Farmers Association hopes that they will keep buying Canadian salmon the year round. The main advantage enjoyed by Canadian salmon exporters (on both coasts) is their proximity to the United States market. Fresh Canadian salmon can reach U.S. consumers in less than 36 hours by truck. This advantage makes Canadian salmon farmers increasingly competitive with other salmon producing nations. It is this advantage that is fueling the drive to produce 30,000 tons of salmon by 1990. B.C. exports, however, have been modest: 78 t in 1984 and 39 t in 1985.

Problems facing the B.C. salmon farming industry include the "gold rush" mentality of some investors, the hesitancy of Canadian bankers to provide loans to salmon farmers, and the lack of detailed knowledge on salmon-rearing techniques, feeds, and diseases as they relate to Pacific salmon species; many salmon farmers in B.C. are experimenting with different growing techniques which may or may not prove profitable for several years.

VI.1 CHILE:1

Chile has been trying for years to develop local fisheries for salmonid species. The first project began in 1905 when trout and salmon were first introduced into Chile. Salmonid species are not indigenous to the southern hemisphere and there are no native salmonid fisheries south of the Equator, even though climatic and environmental conditions suggest that the southern oceans could support wild salmon stocks. The remarkable genetic adaptability of salmonids is making it possible to introduce various species to the southern oceans. Chile's initial experiments with salmon were unsuccessful, but trout was introduced successfully. More recently, Chilean groups working with Japanese and United States experts have reported returns of wild salmon released in Chilean rivers. Researchers now believe that much of the work on salmon ranching was unsuccessful because the fingerlings and eggs were released too far north.

Investors are reporting increasing success with cage culture projects using various salmon species, especially coho salmon. Several companies are experimenting with other species, including Atlantic salmon. Chile's salmon culture industry is based on privately-owned farms located in the south near Puerto Montt, Chiloe Islands, Puerto Aysen, and Magallanes. Nearly 50 private companies have invested over $30 million in the industry. Several private companies are involved, but the most important are Nichiro Chile, Pesqueras Mares Australes, and Salmones Antartica (SA). Salmones Antartica is the largest single company and accounts for about 25 percent of Chile's salmon harvest. There is one Norwegian project to raise Atlantic salmon in Chile. The Fundacion Chile, a private development foundation, has played a key role in promoting the industry and has helped establish Salmones Antartica. The Instituto de Fomento Pesquero, a state-owned fisheries development corporation, has provided some assistance to farmers as have various local governments. The salmon aquaculture industry, however, has primarily been developed with private capital. According to statistics supplied by the Undersecretariat for Fisheries, Chile's farmed salmon production has gone from zero to 1,144 t in 1986 and is projected to reach 17,000 t by 1990 (appendix J). 2/

Chile reportedly imported 14.6 million salmon eggs and locally produced 4.5 million eggs in 1986. There are reportedly 22 firms raising smolts at 91 sites, but data on this production is not available. Chilean smolt production capacity is estimated at 25 million. The Undersecretariat of Fisheries in Chile is planning to enact a series of administrative procedures to regulate the salmon farming industry, including regulations designed to prevent disease transmission between aquacultural facilities and to prevent the importation or export of diseased eggs, smolts, and salmon. The Government of Chile does not have any special policy, fiscal incentives, grants, or subsidies to develop salmon aquaculture. The rapid growth of Chile's salmon farming industry is partially due to a favorable investment climate in Chile along with favorable natural conditions.

2/ The National Marine Fisheries Service believes that the Subsecretaria de Pesca's projections are too high. NMFS believes that 8,000 t by 1990 would be more realistic. A lead article in the May 1987 issue of Fish Farming International indicated that a harvest of 10,000 t might be possible by 1990.

The U.S. Embassy in Santiago estimates that about 80 percent of Chile's salmon production is exported, mostly fresh to the United States. Shipments during the 1986-87 season totaled about 1,000 t valued at $4 to $5 million. Growers believe they might be able to increase shipments to over $430 million by 1990. Chile has an advantage over other salmon growers, in that the peak harvest period is during December to March when fresh wild salmon is not available in the United States. Theoretically, salmon farmers in other countries could also harvest during the same months, but farmers in the northern hemisphere report low yields during those months. Chilean farmers also believe that they can culture salmon at lower costs than in other countries. Chile has many advantages: inexpensive sites, low labor costs, and the availability of inexpensive feed. In addition, Chile's southern coastline stretches for about 2,500 kilometers south of Puerto Montt, offering a vast number of potential sites that the industry has just begun to utilize.

VII.i IRELANDi

The growth in the Irish salmon farming industry may have been promptedi by the country's declining catch of wild salmon, from 2,216 t in 1975 to only 685 t in 1981. Despite the decreased quantity, the value of the Irish salmon catch doubled between 1975 and 1985, stimulating interest in salmon farming.

In 1980, Ireland's production of farmed salmon amounted to a mere 18 tons. The following year, three salmon farms produced 35 t of salmon. In 1985, Ireland had 10 salmon farms with a total output of 700 tons. By 1986, there were 12 major fish farms in Ireland producing 1,500 t of farmed salmon (Irish industry sources report 1,675 t in 1986). Most of these facilities use conventional cage culture, with two or three sites per farm. Annual production is forecast to increase from 1,500 t in 1986 to 10,000 t by 1990 (appendix K).

The Irish Government's involvement and support for salmon culture is fourfold: (1) support of research advisory services, (2) provision of veterinary services, (3) the issuing of fish farming licenses, and (4) the provision of grants for new projects. Part of the Irish salmon culture industry's rapid growth can be attributed to assistance programs administered by the Irish Sea Fisheries Board (BIM) and Udaras na Gaeltachta, the statutory agency charged with the economic, cultural, and linguistic development of the Gaelic speaking areas of Ireland. Both agencies offer capital subsidies ranging from 10 percent to 50 percent, with Udaras offering grants up to 60 percent towards the cost of fixed assets for small scale projects. Both agencies also provide the required national funds necessary to enable salmon farming projects to qualify for EC European Agricultural Guidance and Guarantee Fund aid. Udaras reportedly has spent $5 million on aquaculture programs. In addition, the National Development Corporation (formerly the National Enterprise Agency), the Irish Aquaculture Association (IAA) and its Salmon Producers' Group have invested in the industry. Investments have also been made by private groups, such as the Food Venture Fund which includes Irish and Norwegian investment in specific fish farms. During 1986, about $9 million was invested in the Irish salmon culture industry.

There were 10 smolt farms operating in Ireland in 1986-87. These farms were operated by the Electricity Supply Board (ESB), a semi-state body (which owns 4 smolt farms and produced 220,000 smolts in 1985) and 6 other firms. Smolt production in Ireland is expected to increase very rapidly in 1987-88, as some trout farmers are now converting their existing trout production capacity to smolt production. A number of salmon farms are also building smolt units alongside their growout facilities and two Norwegian firms, Scanfarm and Osco, have proposed anchoring converted oil tankers for smolt production near Cork and Galway. A projected output of 3,000 t per year has been cited, but the plan is being opposed by the Irish Aquatic Association and the Irish Fishermen's Organization. Ireland imports some smolts from Iceland, Norway, and Scotland. However, it is expected that Ireland will quickly become self-sufficient in smolt production and imports will not be required in the future.

There are two diseases which currently afflict Irish fish farms; furunculosis and Infectious Pancreatic Necrosis, a viral disease of salmonids. Also, Ireland will not accept fish from any country where Infectious Hematopoietic Necrosis is present. There is a ban on the import of eggs and live fish into Ireland, except under license granted by the State Fish Pathologists Office. Fish culture licenses are issued on condition that the farmer must notify the Fish Pathologists office of any suspected infection within 48 hours. There can be no movement of fish from one farm to another in Ireland without certification from the same office.

Feed is mostly imported from BP Nutrition, EWOS Baker, and Skretting. There is a majority Norwegian shareholding in each of these companies. Several Irish companies are establishing feed manufacturing operations and it is possible that Ireland could become self-sufficient in a few years. The ability of Irish fishermen to obtain EC quotas, however, for high-quality capelin for reduction into meal remains to be seen.

Table 6.—Ireland. Exports of salmon, by quantity, 1980-86.

Year	Quantity
	Metric tons
1980	300
1981	200
1982	300
1983	700
1984	500
1985	NA
1986	NA

Source: U.S. Embassy, Dublin

Irish farmed salmon is marketed through a variety of channels. Traditionally, Irish salmon has been sold primarily according to the standards and requirements of individual producers. For example, the ESB has always marketed its farmed salmon under the ESB label both domestically and internationally. Other Irish producers sell through associated processing and marketing organizations such as the Irish Salmon Producers Group (ISPG), which is supported by the National Development Corporation and assistance from the BIM. Also, there are firms, such as Fanad Fisheries, who have chosen to market their salmon through Norwegian companies (in this case, A/S Mowi). A significant amount of Irish farmed salmon is used by domestic smokers to produce a high-quality product. Most of the salmon not used by smokers is exported, primarily to EC countries. Ireland exported a record 700 t of salmon (both wild and farmed) during 1983 (table 6).

VIII.i FAROE ISLANDS:i

Salmon culture on the Faroe Islands, a self-governing province of the Kingdom of Denmark, has grown considerably since it first began in 1980. Total production of pen-raised Atlantic salmon was 60 t in 1982 and 1,370 t in 1986. Marine farm production of Atlantic salmon is expected to approach 4,000 t by 1987 and is projected to reach 9,000 t by 1990 (appendix L). According to some reports, if hatcheries could supply more smolts, Faroese fish farms could surpass production estimates. There were 53 salmonid (both salmon and trout) farms in operation on the Faroe Islands at the end of 1986. These farms produced from 30 to 300 t of fish per year. The average production of recently approved farms has been about 100 t annually, a level expected to be maintained in the future.

The Faroese Home-Rule Government supports the salmon farming industry by providing technical assistance and investment loans to fish farmers. These preferential loans, provided by the Faroese Industrial Development Fund, are usually given for 10 years with a 2-year grace period and may cover up to 10 percent of the investment. The Government, concerned about the effects of marine fish farming on the environment, strictly regulates salmon cage farming.

In the early 1980s all smolts used for fish farming in the Faroe Islands were delivered from the public-owned P/F Fiskalling's three freshwater smolt farms. Two private farms were added in 1983 and by 1986 there were six smolt farms in operation in the Faroe Islands (table 7). Some estimate that Faroese smolt production must increase by 1 million smolts annually if its farmed salmon production goal is to be met. Plans are underway to expand smolt production facilities to match the number of new licenses granted each year. All Faroese smolt demand is now being satisfied by domestic smolt production, as imports of smolts are prohibited.

Table 7.—Faroe Islands. Number of firms and farms engaged in raising smolts and total smolt production, 1980-1986.

Year	Firms	Farms	Production
	Number		Million Smolts
1980	1	3	30
1981	1	3	40
1982	1	3	85
1983	3	5	169
1984	3	5	345
1985	3	5	1,255
1986	6	6	1,165

Source: U.S. Embassy, Copenhagen

Occasional outbreaks of whirling disease occurred on the Faroe Islands in the early years of marine farming. In 1970, the Faroe Islands imposed a ban on imports of live salmon, salmon eggs, and salmon fry to avoid diseases (legislation was later expanded to include all live fish, shellfish, and used farm equipment). Since then, no virus or infectious bacterial diseases have appeared in the Faroese fish farming sector. The Faroese Home-Rule Government has employed a veterinarian specifically for control of the fish farming industry. More inspectors are being considered as part of the rapid growth in Faroese salmon farming efforts.

Faroe Islands salmon farmers import some feed from Denmark and Norway, but these imports will be gradually phased out by 1988, with the exception of certain feed additives which cannot be produced locally. The major domestic supplier of feed is the fishmeal factory, Havsbrun, in Fuglefjor, which was significantly expanded in 1986. In view of the historically large Faroese industrial catch, future constraints on feed supplies appear unlikely. In addition, fish reduction facilities are being installed on many Faroese fishing vessels, which ensures not only fresher raw material, but also better utilization of the catch.

Shortly after the first private farm was established in 1981 (to raise steelhead trout), the Home-Rule government established a 4-member fish farm committee to plan the development of this new sector. The committee was replaced in 1985, by a Fish Farm Board with eight members and the following objectives:

oiReserve as many suitable areas as possible for fish farming.i

oiExpand smolt production to keep pace with the granting of newi fish farm licenses.i

oiLimit marine farming in certain areas vulnerable to environmentali effects of fish farming.i

oiProduce a general plan for the use of the limited freshwateri resources.i

The Fish Farm Board is also responsible for reviewing all applications for new licenses and applications for expansion of existing facilities. The Board is drafting new legislation for the fish farm sector, including the establishment of an advisory service and provisions for vocational training.

Faroe salmon exports (wild and farmed) in 1985 were 1,100 t, of which 97 t were fresh or chilled farmed salmon, 902 t of frozen salmon (mostly wild) and 100 t of smoked salmon. In 1985, the Faroese catch of wild salmon was about 650 t, all of which was exported as either smoked or frozen product. In 1986, Faroese salmon exports increased to 2,000 t, of which 577 t were fresh or chilled farmed salmon, 1,316 t of frozen salmon (mostly wild), and 100 t of smoked salmon (table 8). The sharp increase in shipments of fresh or chilled farmed salmon was the result of the introduction of a fast catamaran service between the Faroe Islands and Denmark, which reduced transport time to about 20 hours. In 1986, the Faroese catch of wild salmon amounted to about 600 t, all exported in frozen or smoked form. A significant portion of Faroese salmon exports to Denmark is reexported, primarily to other European countries.

Table 8.—Faroe Islands. Exports of fresh or chilled farmed salmon, by country, quantity, and value, 1985-1986.

Country	Year			
	1985	1986	1985	1986
	Metric tons		US$1,000	
Denmark.....	50	392	306	1,945
Spain.....	-	57	-	304
FRG.....	24	48	167	275
France.....	-	36	-	185
Sweden.....	21	24	138	166
United States...	-	9	-	68
Great Britain...	-	7	-	35
Netherlands.....	-	2	-	13
Switzerland.....	1	1	1	4
Belgium/Lux.....	1	-	5	-
Total	97	577	623	2,997

Source: U.S. Embassy, Copenhagen from data supplied byi Faroese export statistics. Exchange rates: US$1.00 equals DKr 10.59 for 1985 and DKr 8.09 for 1986.

Denmark serves as an important distribution center for Faroese salmon; much of Faroese salmon is either shipped out to other countries as fresh product or is smoked in Denmark and re-exported. Faroese salmon is slowly developing markets in a number of countries. The United States imported only $68,000 worth of Faroese salmon during 1986.

IX.iICELAND:i

Icelandic aquaculture is a fairly recent phenomenon, owing to the success of its traditional fisheries. Until very recently, highseas fishing has more than provided Icelandic fishermen and processors with high quality raw material. However, the limited growth potential of traditional fish stocks has spurred interest in developing new fisheries. A ban on commercial salmon fishing in Icelandic waters since 1933 has provided an impetus for developing domestic sources of salmon. After years of leaving salmon culture to small individually-managed pilot operations, large companies (primarily Norwegian), are investing in large-scale facilities.

Iceland's Atlantic salmon production comes primarily from ocean ranching, or the release of salmon smolts into natural rivers and streams. Salmon ranching began at the state salmon hatchery near Kjollafjordur in 1961. Icelandic ocean cage or pen farming has not been as successful as it has been in Norway because Iceland lacks sufficiently protected fjords and water temperatures are too cold during the winter. Icelandic scientists are nonetheless continuing efforts to develop the pen farming of Atlantic salmon. Icelandic salmon ranching is expanding and may contribute significantly to future fishery exports. During 1986, the number of Icelandic farms culturing salmon grew from 18 to 50. Of these, 15 are land-based farms and 35 are sea-pens. Iceland's farmed salmon production has increased from 20 t in 1981 to 123 t in 1986 (appendix M).

The world's largest dry-land salmon farm recently opened in southwest Iceland, at Grindavik. The farm, Strandeldisstod Islandslax Ltd., is a joint venture between Samband (51 percent), and a Norwegian company, Norlax (Noraqua and Teleinvest, 49 percent). The firm was built with the help of the Nordic Investment Bank. The company started in 1984, when tanks for raising smolts were built. The eggs were first imported from Norway, but Islandslax is now self-sufficient in eggs. The firm expects to produce 300 t of salmon for export to the United States and the United Kingdom in 1987. Production is expected to reach 700 t annually by 1990. Also under construction by Islandslax Ltd., with help from the Nordic Investment Bank, is a farm designed to produce some 500 t annually, eventually reaching 5,000 t per year. Islandslax also plans to export "super smolt" which weigh about 150 grams (as opposed to 50 gram smolts). The "super smolt" grow very rapidly in Iceland because of the abundance of naturally heated water from thermal springs. The smolts are shipped to Ireland where they are raised in sea pens, which results in a faster growing cycle. In 1986, of the one million smolts hatched by Islandslax, 0.2 million were used by the company and the remainder was exported. The firm has agreed to let the Marine Research Institute establish a research station at the farm to observe experimental programs, including the breeding of halibut.

Currently, salmon smolt production is the most valuable aspect of Icelandic salmon aquaculture, followed by ocean ranching, and farming salmon. During 1985, some 16 rearing units produced 821,700 smolts, an increase of 4 percent over 1984. There are reportedly 36 units in Iceland, with a total production capacity of 5.3 million smolts. Icelandic smolt producers have begun exporting sizeable quantities of smolts to Ireland and Norway, where prices for smolts have risen by 80 to 100 percent. During 1986, more than 1 million Icelandic smolts worth $2 million were exported to Norway and Ireland. Norwegian farmers imported 700,000 million salmon smolts and Irish fish breeders purchased 80,000 salmon smolts from Iceland in 1985. Because of the high prices offered elsewhere, Iceland has experienced a shortage of smolts for its own salmon culture industry.

As in other countries' salmon farming industries, the Norwegians have played an important role in Icelandic salmon farming. The Icelandic-Norwegian joint venture company (ISNO), at Oxarfjordur produced about 35 t of farmed salmon in 1984 and 85 t in 1985. The Fisheries Association of Iceland has operated an experimental station at the ISNO site since 1977. The site is located in a lagoon in floating pens. The facility is protected from severe weather and sea conditions by a sand bar with two openings to the sea. Heated freshwater from nearby springs located along the shore help maintain a constant temperature. Salmon grown in these pens reach 1.5 to 5 kilograms each in two years. The firm's partner is Mowi of Norway (45 percent ownership). The ISNO also releases small numbers of smolts into the sea as part of a salmon ranching operation.

A U.S. salmon farming company, in a joint venture with an Icelandic investment company, plans to eventually produce 2,100 t of pen-farmed salmon annually in Iceland. The Icelandic Freezing Plants Corporation (IFPC), Iceland's largest exporter of fish and fishery products, is presently studying several farming and ranching projects, primarily involving salmon.

The Pathology Division of the Directorate of Veterinary Services (DVS), an agency supervised by the Ministry of Agriculture, has primary responsibility for disease control among fish farms. The U.S. Embassy in Reykjavik was told that Icelandic Government veterinarians routinely take samples from smolt farms and that if any trace of disease is found, the farm is denied the right to export. Further, measures are taken to assure that diseased fish do not contaminate others around them. The movement of smolts from farm to farm is also controlled. Additionally, buyers of smolts invariably demand that the veterinary services approve the smolts they intend to buy. As a general policy, the DVS carries out random checks of farms for the purpose of disease control.

The agencies involved in salmon aquaculture are the Health Protection Agency (a consultative body under the Ministry of Health with the authority to issue operating licences), the Nature Conservation Council (an advisory body with the right to veto projects considered detrimental to the environment), the Directorate of Freshwater Fisheries (a government agency whose objective is to promote the growth of the salmon industry), and the State Veterinarian (operating under the Ministry of Agriculture).

The Icelandic Government operates some 40 salmon hatcheries and research stations, but does not provide financial incentives to salmon farmers. The Government of Iceland does not provide direct grants to the salmon farming industry. Loans are made by semipublic institutions, the Regional Development Fund, while the Fisheries Investment Fund guarantees loans. Total credit granted to the industry from 1981 to 1987, has been about $31 million. Credit and loans are also available from commercial banks, but commercial loans are limited to 30 percent of the insured value of the firm. The only other "incentive" given the salmon farming industry is the ability to purchase imported investment goods free of sales tax.

The major task facing the Icelandic salmon industry is to develop internationally recognizable salmon quality groupings and to apply standardized criteria to each. The large salmon farms, such as ISNO and ISLANDSLAX, which are seriously attempting to develop markets in Europe and the United States, apply strict quality controls.

Icelandic salmon farmers rely on the following companies for feed: Fodurblandan, Istess (both having some foreign participation), Mjolkurfelag Reykjavikur and Lysi-Sildar-OG Fiskimjolsverksmidjan. The first three firms produce dry feed while the last firm produces a wet feed. Special feed used for smolts and some small salmon is imported from Norway and Sweden, but there are plans to produce this type of specialty feed in Iceland in the near future. Iceland should be able to produce high quality feed from capelin, but capelin catches have fluctuated sharply in recent years.

X.t<u>NEW ZEALAND:</u>t

New Zealand has no indigenous salmonid species. The Auckland Society introduced sockeye salmon to New Zealand's South Island in 1900 to establish a recreational fishery. The New Zealand Government later introduced chinook salmon, or quinnat, as it is called in New Zealand, in order to begin a commercial fishery. Chinook salmon is now found in major east coast rivers and lakes of the South Island and sockeye is restricted to the Waitaki River basin. Atlantic salmon is also present in New Zealand in several lakes and is being used in experimental sea-cage culture. Commercial production however, remained a dream until 1972, when limited ocean ranching was allowed (in order to enhance ailing wild salmon runs). By 1976, New Zealand had two large ocean ranching operations underway. One of these, Bubbling Springs Salmon Farm, became the country's first salmon farming operation in 1978. In 1983, the New Zealand Salmon Company became the first salmon farming concern to be listed on the New Zealand stock exchange. New Zealand salmon farmers produced 700 t in 1985 and expect to produce about 3,500 t by 1990 (appendix N).

In 1986, New Zealand had a total of 15 ocean-ranching farms, 19 pond-rearing, and 12 sea-cage farms. Most of these are located along the coast of Stuart Island. In 1985 there were also 11 smolt farms in operation. To date, the supply of salmon stock to New Zealand farmers comes essentially from wild populations, although returns from Government hatchery stock have become increasingly important in meeting this need. In 1984, the entire salmon stock requirement of farmers, beyond that met by brood stock production, came from Government hatchery returns. This trend is likely to continue in the future. Originally the New Zealand Government decided to supply two full cycles of chinook salmon to farmers, thereby ensuring a supply of smolts and eggs for up to 6 years and an induced return to the release facility. By 1980, there were six ocean ranching operations, requiring about 3 million eggs annually. New Zealand's wild stocks have been unable to sustain that level of egg removal so there have been some egg shortages. To counter this problem, farmers have been experimenting with maturing their own chinook brood stock to maturity in fresh water only, with mixed results. Farmers are not allowed to rear and sell wild stock given to them directly by the Government, hence the need to maintain their own broodstocks or obtain the surplus stock from other farmers.

The New Zealand Salmon Company's ranching operations are some of the most modern in the world. Its hatchery is capable of producing 8-10 million eggs per year. The company has also established a reliable adult salmon run at the hatchery. New Zealand Salmon's Christchurch feed plant provides feed for all phases of the culture operation. The heart of the company is on Stewart Island where approximately 120 ocean-pens are being used to raise salmon to market size and harvest after 1 to 2 years in salt water. The Stewart Island operation has a production capacity of 350 t and reached 200 t in 1986. New Zealand Salmon has a ranching operation at Tentburn. The Tentburn operation apparently did not have satisfactory returns in 1986 and blames a "major ocean effect which is not yet understood" for the problem.

New Zealand farmers enjoy several distinct advantages over northern salmon producers. The country has an excellent supply of unpolluted fresh water (although a pending seapen anti-fouling issue might prove a roadblock to the ocean cage-farming sector of the salmon industry). New Zealand's salmon stocks are relatively disease-free (although the country did experience an outbreak of whirling disease several years ago). New Zealand also enjoys a market advantage in the Northern Hemisphere because harvests coincide with the off-season; New Zealand fresh salmon goes on sale when wild salmon is not available. Currently, Chile is the only other country that can offer direct competition on this point. New Zealand king salmon commands a premium price on foreign markets because of its quality and scarcity. In addition to the geographical advantages, New Zealand farmers have a cheap and plentiful supply of smolts available. Disease problems are minor, and technology is excellent.

One distinct disadvantage New Zealand may face in the long run is its location. Except for Australia (Tasmania), New Zealand is the salmon producing country located the greatest distance from major importing countries. As salmon culture develops in New Zealand's principle salmon markets, the United States and other importing countries, and products from these countries become competitive in their own markets, the cost of shipping fresh salmon may eventually price New Zealand out of the foreign marketplace. New Zealand has been exporting salmon to nearby Australia, but that country has only a small market for salmon.

The Fisheries Research Division of the New Zealand Ministry of Agriculture and Fisheries operates the Glenariffe Salmon Research Station on a tributary of the Rakaia River in Canterbury. The Station which carries out research on chinook salmon, began as a fish trap on the Glenariffe stream in 1985. Glenariffe has been a major supplier of eggs since ocean ranching began in New Zealand in the mid-1970s. Ocean ranches have a large demand for salmon eggs, because a large number of fish have to be released to obtain return. Only a small percentage survive to return to the release point (fish are captured and killed before their eggs ripen). The station has also been used to study the biology, life history, age structure, and juvenile survival and production of chinook salmon. In addition, studies on salmon nutrition and sex control are currently underway at Glenariffe.

Although cage farming has the advantage of year-round salmon production, salmon ranching has supplied New Zealand with the major source of product for world markets. Most ranchers also maintain cage culture operations. The future for ocean ranching appears promising if an adequate management program can be devised to prevent the "incidental" catch of ocean salmon by trawlers.

XI. SWEDEN:

Swedish aquaculture began approximately 200 years ago when farmers began raising trout, carp, and tench in small ponds. Most of this production remained small and isolated in underdeveloped rural areas. Aquaculture in Sweden began to expand in the late 1970s, focusing on the production of rainbow trout, salmon smolts (for release into the Baltic Sea), eels, sea trout, and blue mussels. Production of farm-raised salmon remains small. In 1982, Swedish salmon farmers reported producing 10 t of farm-raised salmon (live weight). Production remained low in 1983 (15 t) and 1984 (20 t), but increased to 80 t by 1985 and is projected to reach 300 t in 1986 (appendix O).

The responsibility for aquaculture in Sweden rests with the National Board of Fisheries, which received formal responsibility for commercial fish farming in 1984. The National Board of Fisheries is responsible for the establishment of new fish farms, disease control, and the effects of fish farms on the environment. The agency estimates that about 500 salmon farms operated as family enterprises in Sweden in 1986, but large operations accounted for a significant portion of Sweden's smolt or salmon production. Sweden produces salmon smolts for release into the wild, for export, and for use in fish farming. A significant portion of Sweden's salmon smolt production has been used to restock rivers flowing into the Baltic Sea. The Swedish Water Law requires companies who build (or have built) hydroelectric dams to build hatcheries to compensate for the loss of natural waterways used by spawning salmon. In 1984, an estimated 4 million smolts were used to restock Swedish rivers (this includes brown trout). Swedish production figures are not available, but exports of smolts(salmon and trout) have grown rapidly from 10 t in 1980 to a record 311 t in 1985,before declining to 156 t in 1986, when 173 firms were reported to be producing smolts. Swedish imports of smolts exceeded exports in 1980, but have since lagged behind similar exports (table 9). The lack of statistical data for salmon, unfortunately, makes it difficult to clearly identify salmon smolts among the various possible imports and exports of salmon and trout.

Table 9.—Sweden. Imports and exports of salmon smolts, by quantity, 1980-1986.

Year	Imports	Exports
	Metric tons	
1980	32	10
1981	35	48
1982	8	55
1983	13	104
1984	29	95
1985	57	311
1986	48	156

Source: U.S. Embassy, Stockholm

The Government of Sweden has provided support to the aquaculture industry. Between 1980 and 1984, the Government provided $6.0 million in assistance, including $1.5 million to aquaculture farms in economically weak rural areas. The Swedish Government has also allocated about $0.5 million for aquaculture research, much of which is conducted at the Swedish University of Agricultural Sciences in Uppsala.

Export statistics indicate that Sweden shipped 409 t of salmon worth $1.8 million in 1985, and 273 t valued at $1.3 million in 1986 (table 10). Since Sweden's total production of farm raised salmon was 80 t in 1985 versus exports of 409 t, it can be safely assumed that the majority of salmon exports consisted of wild salmon in 1985. The situation in 1986, however is different; production of 300 t of farm-raised salmon could account for a much greater share of the 273 t exported in 1986. It is likely that Sweden will begin to export more farm raised salmon in 1987.

Table 10.—Sweden. Farmed salmon exports, by country, by quantity, and by value, 1985-1986.

Country	1985	1986	1985	1986
	Metric tons		US$1,000	
Belgium	26	-	121	-
Denmark	57	196	164	752
FRG	-	60	-	298
Finland	73	-	315	-
France	28	47	237	298
Netherlands	-	8	-	47
Norway	47	45	349	247
Others	42	53	154	129
Total	273	409	1,340	1,771

Source: U.S. Embassy, Stockholm. The exchange rate between the U.S. dollar and the Swedish Kroner was 7.11 kroner per dollar in 1986 and 8.59 kroner per dollar in 1985.

XII. SPAIN

Salmon aquaculture is still in its earliest phases of development in Spain. Marcultura, with offices in Santiago de Compostella, is the only company currently engaged in salmon farming in Spain. Marcultura has been in business for 12 years and has been raising Pacific salmon since 1984. The firm initially farmed Pacific coho salmon, but began raising Atlantic salmon in 1987. They do not export salmon and do not plan to export, since they are currently providing only 10 percent of Spain's total demand for salmon. Production for 1987 is estimated at 200 t of Pacific salmon. By 1990, Marcultura expects production to reach 600 tons (appendix P).

The U.S. Embassy in Madrid reports that several Norwegian companies plan to establish salmon farms in northern Spain in 1988. The number of sites and their production potential is not yet available, but it will expand Spanish salmon farming within the next 2 to 3 years. Salmon farming has not done well in Spain due to disease and high temperatures. Warmer waters enable salmon to reach sexual maturity at very low weights (1.5 to 2.0 kilograms apiece), forcing the fish to be harvested while they are still very small. The Norwegians reportedly have found a solution for both the disease and early maturation problems.

The Norwegians are attracted to Spain, because of a growing demand for salmon and because of attractive benefits for investors. Ten of Spain's 17 autonomous regions provide 40 percent financing in the form of grants to new aquaculture businesses through the "Consejeria de Pesca" (Fisheries Council) of each autonomous region. Investment incentives have included grants, tax exemptions, state loans, and grants for employment.

Spain is a net importer of salmon. Most of Spain's salmon is imported from Norway (1,700 t in 1986). Imports of processed salmon are subject to a 12 percent import duty. The Norwegian Commercial Mission in Spain has a "vigorous promotion program for Norwegian salmon", staffed by three Norwegian officers. Spain could become an important new market for Norwegian farmed-raised salmon in the next few years.

XIII.1 FRANCE1

Historically, French aquaculture most often involved the farming of shellfish (oysters and clams). However, in recent years, the culturing of new (salmon, trout, seabass, seabream) and experimental (algae, flat fish, tropical fish) species has become more popular. Currently, farm-raised salmon represents only a small part of total French aquacultural production.

French salmonid (both salmon and trout) culture is concentrated in the northwest region of Brittany (Camaret and Le Conquet), where there are 10 operations producing about 500 t of rainbow trout and coho salmon. These operations are handled under the technical supervision of the Breton Oceanological Center (government supported). Although the emphasis has been on trout farming, pilot production of coho salmon has reached 80 tons. By 1990, the annual production of farmed salmon could amount to 500 tons. French salmon farmers have reported problems in maintaining good survival rates due to high temperatures during the summer months. This, according to the farmers, prevents the production of salmon large enough to compete with imported farmed and wild salmon on the lucrative French market. French scientists from the National Institute for Agronomy Research (INRA) and the Institut Francais pour la Recherche et l'Exploitation de la Mer (IFREMER) are currently studying this problem atl their three joint research stations in Camaret, Squirriou, and Rennes.l

Overseas, the French Regional Association for the Development of Aquaculture (ARDA) and the ISTPM have established pilot production of trout and Atlantic salmon on the islands of St. Pierre and Miquelon, off Canada's Atlantic coast. In the southern Indian Ocean (Kerguelen Islands), INRA is reportedly getting good results from a salmon sea-ranching operation begun in 1983.

XIV.1 FINLAND1

Finland is not a major salmon farming country. It was not untill post-World War II, when construction of hydroelectric power plants destroyed natural spawning grounds for salmonid fish, that efforts were begun to protect fish stocks. To compensate, the government established a hatchery system, producing smolts for release into coastal rivers and lakes for commercial and sports fishermen. The culture of brown trout is the most common form of aquaculture in Finland. Atlantic salmon aquaculture is mostly restricted to smolt production, but small quantities of farmed salmon are raised for sale. There were 461 fish farmers in Finland in 1986. There is no specific government subsidization of fish farming in Finland. Farms located in "development areas" can obtain favorable loan packages from the Development Area Fund (KERA) for fish farm operations.

Finland's farmed salmon production began in the early 1980s. Between 1980 and 1983, approximately 30 t of farmed salmon was produced annually in Finland. In 1984, the quantity of farmed fish (salmon and trout) amounted to 94 t and by 1985 production of these two species reached 100 t, which is expected to remain constant until 1990 (appendix Q).

In 1987, two Finnish firms, Savon Taimen OY and Hanka-Taimen OY announced plans to establish a joint venture fish farming operation in Scotland. The venture, established in January 1987, was named Risbond Fishfarms and was scheduled to import 400,000 salmon eggs from Finland for raising in Scotland (beginning in late February or early March 1987). The venture plans to raise 250 t of salmon during its initial stages. The company's long-term plans call for the production of 1,000 tons. Salmon eggs will be sent from Finland starting in February 1987 (approximately 400,000 eggs will be shipped). Feed will be obtained from a Scottish fodder plant near the facility.

There were 126 Finnish smolt farms operating in 1986, and all were dependent on the Finnish Game and Fisheries Research Institute (FGFRI) for eggs, fry, and/or fingerlings, allowing the FGFRI to control the genetic composition of the parent fish. Salmon smolt production has flourished at the expense of adult salmon production because cold temperatures inhibit the growth of salmon. Smolt production increased from 1 million in 1980, to 1.6 million in 1984, to 2.3 million in 1985. The outlook for future smolt production is expected to grow at 10 to 20 percent per year through 1990.

Finnish salmon exports are small. In 1985, Finland exported 66 t of fresh and chilled salmon worth $306,000 (this figure includes wild and farmed salmon). Exports in 1986 were only 1 t worth $9,000, which was shipped to Switzerland, West Germany, and Italy.

XV. AUSTRALIA:

Australia's salmon aquaculture program is located on the island of Tasmania to the south of the Australian mainland where conditions are reportedly "ideal" for farming Atlantic salmon. In 1985, the Tasmanian Government's Foreign Investment Review Board and the Noraqua Group from Norway established a joint venture called Tassal Ltd. (79 percent Norwegian ownership and 21 percent Tasmanian ownership) for the culture of salmon; Tassal Ltd. now controls about 40 percent of all salmon production. Tasmania Atlantic reportedly produces 11 percent of total production and about 17 other firms control the remaining 49 percent of Australia's salmon farm production.

Noraqua reportedly was attracted to Tasmania by the low variation in water temperatures, the cleanliness of the water, and because of the advanced infrastructure available. According to the Deputy Chairman of Tassal Ltd., Stal Svenning (who is also a Vice President of the Norwegian parent company), the Tasmanian operations are "the most promising of anywhere in the world." The time it takes from hatching to harvest, for a four to five kilogram salmon, reportedly is 27 to 30 months compared to 36 to 48 months in Norway.

Tassal Ltd. is planning to develop the Australian market for salmon. It has an entitlement to 40 percent of all salmon smolt in Tasmania through 1995 and will be able to market its salmon in Australia without fear of foreign competition; Australian quarantine restrictions on imported fresh salmon (and trout) require that the fish be heat treated — a process that reportedly impairs quality and taste. Tassal Ltd. is optimistic about its ability to meet the demand for fresh salmon in Australia through 1990.

XVI. CONCLUSION:

World salmon aquaculture is a very dynamic business. New ventures are starting up all over the world. Research into new salmon raising techniques are producing results that will make salmon farming more predictable in the future, thus attracting more investment. It appears likely that world farmed salmon production will exceed the 200,000 t mark in the next few years. It is also logical to expect outbreaks of disease periodically, increased competition, periods of consolidation within the industry, and increased investments in salmon farming around the world -- led primarily by Norwegians -- and gradual expansion of markets for salmon as consumers react to steady supplies of high quality salmon throughout the year.

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Salmon aquaculture update

October 30, 1987

Appendix A.--World. Farmed salmon production, by quantity, and country, 1980-86.

Country	Year						
	1980	1981	1982	1983	1984	1985	1986
	Metric tons*						
EUROPEAN COMMUNITY:							
France	30	40	40	40	50	60	200
Ireland	21	35	100	257	385	722	1,500
Spain	-	-	-	-	100	150	150
U.K.	598	1,333	2,136	2,536	3,912	6,921	10,338
EC, total	649	1,408	2,276	2,833	4,447	7,853	12,188
NON-EC EUROPE:							
Faroe Islands	-	-	60	105	116	470	1,370
Finland	-	30	30	30	94	100	100
Iceland	-	20	30	50	107	91	123
Norway	4,143	8,422	10,266	17,000	22,300	28,655	45,675
Sweden	-	-	10	15	20	80	300
Non-EC, total	4,143	8,472	10,396	17,200	22,637	29,396	47,568
NORTH AMERICA:							
Canada:							
Atlantic	6	35	140	180	200	300	400
Pacific	157	176	273	128	107	120	600
N.America total	163	211	413	308	307	420	1,000
OTHER:							
Chile	-	1	184	94	109	500	1,144
Japan	1,855	1,150	2,122	1,760	5,049	6,430	8,000
New Zealand	-	2	5	10	10	250	500
Other, total	1,855	1,153	2,311	1,864	5,168	7,180	9,644
GRAND TOTAL	6,810	11,244	15,396	22,205	32,559	44,849	70,400

*Live weight.

Source: U.S. Embassy reports based on various official statistical tables or reports. Some 1986 figures are preliminary estimates.

Appendix B.—World. Projected farmed salmon production, by quantity and country, 1987-1990.

Country	Year 1987	1988	1989	1990
		Metric tons*		
EUROPEAN COMMUNITY:				
France	200	200	200	200
Ireland	2,210	4,520	6,630	10,100
Spain	200	300	450	600
U.K.	13,950	15,000	20,000	25,000
EC total	16,559	20,020	27,280	35,900
NON-EC EUROPE:				
Faroe Isl.	4,800	4,800	7,100	9,000
Finland	100	100	100	100
Iceland	800	1,750	2,500	5,000
Norway	53,000	74,000	74,000	100,000
Sweden	400	800	1,000	1,000
Non-EC total	59,100	81,450	84,700	115,100
NORTH AMERICA:				
Canada:				
Atlantic	800	1,600	3,200	5,000
Pacific	3,200	8,400	14,600	23,000
N.Am. total	4,000	10,000	17,800	28,000
OTHER:				
Chile	1,720	7,522	15,410	17,000
Japan	13,000	15,000	17,000	19,000
New Zealand	1,000	1,500	2,000	3,000
Other, total	15,720	24,022	34,410	39,000
GRAND TOTAL	95,379	135,492	164,190	218,000

*Live weight

Source: U.S. Embassy reports based on various official statistical tables or reports.

Appendix C.--World. Production of farmed salmon, by species, and quantity, 1980-1986, with projections to 1990.

Year	Species		
	Atlantic	Pacific	Total
	Metric tons*		
1980	4,798	2,012	6,810
1981	9,915	1,329	11,244
1982	12,812	2,584	15,396
1983	20,213	1,992	22,205
1984	27,184	5,375	32,559
1985	37,399	7,450	44,849
1986	60,006	10,394	70,400
1987	76,259	19,120	95,379
1988	102,770	32,722	135,492
1989	114,730	49,460	164,190
1990	155,400	62,600	218,000

*Live weight.
Source: U.S. Embassy reports based on various official statistical tables or reports. NMFS believes the figures for Pacific salmon for 1988-1990 are too high.

Appendix D.--World. Production of farmed salmon versus catch of wild salmon with projections to 1990.

Year	Fishery		
	Farmed	Wild	Total
	Metric tons*		
1980	6,810	580,788	587,598
1981	11,244	661,922	673,166
1982	15,396	577,529	592,925
1983	22,205	701,718	723,923
1984	32,559	653,303	685,862
1985	44,849	838,885	883,734
1986	70,400	700,000**	770,400
1987	95,379	800,000**	895,379
1988	135,492	700,000**	770,400
1989	164,190	800,000**	964,190
1990	218,000	700,000**	918,000

*Live weight
**NMFS estimates.
Source: U.S. Embassy reports based on various official statistical tables or reports, and FAO Yearbook of Fishery Statistics.

Appendix E.—Norway. Farmed salmon production, by quantity, 1980-1986, with projections to 1990.

Year	Production
	Metric tons*
1980	4,153
1981	8,422
1982	10,266
1983	17,000
1984	22,300
1985	28,655
1986	45,675
1987	53,000
1988	74,000
1989	74,000
1990	100,000

*Live weight.
Source: U.S. Embassy, Oslo. Based on information provided by the Norwegian Fisheries Ministry and the Norwegian Fish Farmers Sales Organization "Fakta/Facts", Fiskeoppdretternes Salgslag A.L. and Norwegian Ministry of Fisheries, personal communication (for 1990)."

Appendix F.—U.K. Farmed salmon production, by quantity, 1980-1986, with projections to 1990, and number of farms.

Year	Production	Farms		Total
		Freshwater	Saltwater	
	Metric tons*	Number of Farms		
1980	598	NA	NA	NA
1981	1,333	27	35	62
1982	2,152	37	46	83
1983	2,536	41	62	103
1984	3,912	46	83	239
1985	6,921	66	128	194
1986	10,338	-	-	-
1987	13,950	-	-	-
1988	15,000	-	-	-
1989	20,000	-	-	-
1990	25,000	-	-	-

*Live weight.
Source: U.S. Embassy, London. Based on information provided by the Department of Agriculture and Fisheries For Scotland.

Appendix G.--Japan. Farmed coho salmon production, by quantity, and number of farms, 1980-1986, with projections to 1990.

Year	Production	Farms
	Metric tons*	Number
1980	1,855	NA
1981	1,150	NA
1982	2,122	NA
1983	1,760	150
1984	5,049	180
1985	6,430	224
1986	8,000	350
1987	13,000	400
1988	15,000	NA
1989	17,000	NA
1990	19,000	NA

*Live weight.
Note: 1987 projections include 20-25 t of farmed chinook salmon.
Source: Ministry of Agriculture, Forestry, and Fisheries. Report on Fisheries and Aquaculture for 1980-85. Minato Shinbun, 4/25/87 (1986 date). U.S. Embassy discussions with members of the Japanese salmon farming industry (1987-1998 projections).

Appendix H.—Canada. Farmed salmon production, by region, and quantity, 1980-1986, with projections to 1990.

Year	Region		Total
	Atlantic	Pacific	
	Metric tons		
1980	6	157	163
1981	35	176	211
1982	140	273	413
1983	180	128	308
1984	200	107	307
1985	300	120	420
1986	400	600	1,000
1987	800	3,200	4,000
1988	1,600	8,400	10,000
1989	3,200	14,000	17,200
1990	5,000	23,000	27,000

*Live weight.
Source: Commercial and Market Analysis Division, Policy and Program Planning, Department of Fisheries and Oceans, Ottawa, 1987.

Appendix I.—Canada. Farmed salmon production in British Columbia, by quantity and value, 1980-1986, with number and hectares of farms.

Year	Quantity	Value	Farms	Hectares
	Metric tons*	C$1,000	Number	
1980	157	898	2	2
1981	176	985	NA	NA
1982	273	1,136	NA	NA
1983	128	708	NA	NA
1984	107	702	10	33
1985	120	820	37	124
1986	600	NA	69	270

*Live weight.
Source: Commercial and Market Analysis Division, Policy and Program Planning, Department of Fisheries and Oceans, Ottawa, 1987, and Fish Farming International, August 1987 (data for farms & hectares).

Appendix J.—Chile. Production of farmed salmon, by quantity, 1980-1986 with projections to 1990 and number of salmon farms.

Year	Production	Farms
	Metric tons*	Number
1980	NA	1
1981	60	1
1982	184	2
1983	94	5
1984	109	6
1985	500	11
1986	1,144	22
1987	1,700	NA
1988	3,000 - 7,500	NA
1989	5,000 - 15,000	NA
1990	8,000 - 17,000	NA

*Live weight.
Note: NMFS has received a wide range of estimates concerning projected production. The range is presented in the tables.
Source: Servicio Nacional de Pesca. Annuario Estadistico de Pesca, various years (1980-1986 data). U.S. Embassy and various press sources (1987-1990 projections).

Appendix K.—Ireland. Production of farmed salmon, by quantity, 1980-1986, with projections to 1990.

Year	Production Metric tons*
1980	21
1981	35
1982	100
1983	257
1984	385
1985	722
1986	1,500
1987	2,200
1988	4,500
1989	6,500
1990	10,000

*Live weight.
Source: U.S. Embassy, Dublin.

Appendix L.—Faroe Islands. Production of farmed salmon, by quantity, 1980-1986 with projections to 1990, and number of salmon farms.

Year	Production Metric tons*	Number of Farms Number
1980	-	6
1981	-	6
1982	60	12
1983	105	22
1984	116	30
1985	470	50
1986	1,370	53
1987	4,800	NA
1988	4,800	NA
1989	7,000	NA
1990	9,000	NA

*Live weight.
Source: U.S. Embassy, Copenhagen, from data provided by the Faroese Fish Farming Board (Aliradid).

Appendix M.--Iceland. Production of farmed salmon, by quantity, 1980-1986 with projections to 1990, and number of salmon farms.

Year	Production Metric tons*	Farms Number
1980	-	NA
1981	20	NA
1982	30	NA
1983	50	NA
1984	107	NA
1985	91	18
1986	123	50
1987	800	NA
1988	1,750	NA
1989	2,500	NA
1990	5,000	NA

*Live weight.
Source: U.S. Embassy, Reykjavik, from information provided by the Directorate of Freshwater Fisheries and the Union of Icelandic Fish Farms (1984-86) and Curt Kerns, World Salmon Farming, - An Overview with Emphasis on Possibilities and Problems in Alaska, University of Alaska, Marine Advisory Bulletin #26, December 1986.

Appendix N.—New Zealand. Production of farmed salmon, by quantity, 1980-1986 with projections to 1990.

Year	Production Metric tons*
1980	-
1981	2
1982	5
1983	10
1984	10
1985	700
1986	800
1987	1,000
1988	1,500
1989	2,000
1990	3,000

*Live weight.
Source: U.S. Embassy, Wellington.

Appendix O.—Sweden. Production of farmed salmon, by quantity, 1980-1986, with projections to 1990.

Year	Production Metric tons*
1980	-
1981	-
1982	10
1983	15
1984	20
1985	80
1986	300
1987	400
1988	800
1989	1,000
1990	1,000

*Live weight.
Source: U.S. Embassy, Stockholm.

Appendix P.—Spain. Production of farmed salmon, by quantity, 1980-1986, with projections to 1990.

Year	Production Metric tons*
1980	-
1981	-
1982	-
1983	-
1984	100
1985	150
1986	150
1987	200
1988	300
1989	450
1990	600

*Live weight.
Source: U.S. Embassy, Madrid. Data provided by Marcultura of Spain.

Appendix Q.—Finland. Production of farmed salmon, by quantity, 1980-1986, with projections to 1990.

Year	Production Metric tons*
1980	-
1981	30
1982	30
1983	30
1984	94
1985	100
1986	100
1987	100
1988	100
1989	100
1990	100

*Live weight.
Source: U.S. Embassy, Helsinki. Data provided by Finnish Ministry of Agriculture and Forestry, and by the Research Institute of Game and Fishery. Figures include brown (Sea) trout (S. trutta).