EXECUTIVE SUMMARY

- The purpose of this report is to identify the social and economic impacts of the existing salmon farming industry in British Columbia. It was commissioned by the Environmental Assessment Office to provide context to its environmental review.
- The report is based on surveys of salmon farming and key supplier companies, a survey of marine tourism operators in the Broughton Archipelago, extensive interviews with industry, community and other stakeholder representatives and a number of reports and presentations on salmon farming in B.C.

Industry Characteristics

- There are 16 salmon farming companies currently operating in B.C., at 79 active grow-out sites. Total production in 1996 exceeded 25,000 tonnes—some 17,000 tonnes of Atlantic salmon and 8,400 tonnes of Pacific (mostly chinook) salmon.
- The industry has concentrated into fewer, larger firms in recent years. Most of these firms are multi-national, with operations in Norway, Chile, the U.S. and other areas. The firms are also largely vertically integrated, often involved in hatchery, transportation, processing and/or sales as well as grow-out operations.
- A large percentage of B.C. production (84% in 1995) is exported, mostly in fresh, head-on form. An increasing amount of value-added production (e.g., fresh and frozen fillets) is being exported because of shifting buyer preferences. Market destinations are also shifting (e.g., more sales to Asia), because of increased competition in traditional U.S. markets.
- British Columbia's share of the world market is relatively small (4.3% in 1995). Its share has fallen in recent years because of the large increases in production in other countries, in particular Chile, where production increased from 3,000 tonnes in 1988 to 126,000 tonnes by 1995. Norway is the largest world producer at 251,000 tonnes in 1995—10 times the level of B.C. production.
- British Columbia is well located to compete globally, but does suffer from relatively high costs and sub-optimal scale of operations. The industry has been profitable in recent years due to greater productivity and reduced costs. The level of government support is now quite small. There are no direct subsidies and indirect government support is estimated at some $3.65 million, much less than in most other agricultural industries or in the commercial salmon industry.

Impacts of Farmed Salmon Production and Sales

- The salmon farming industry generated revenues of $167 million in 1996. Over $30 million of that was profit (before interest, depreciation and taxes) for industry; the balance went to labour and the purchase of materials, services and supplies.
- The industry directly created 1,142 person years of employment in 1996. Over 40% of these were in grow-out operations; almost 30% in processing; and the rest were in hatchery, transport, sales and administration. Employment in grow-out activity has fallen in recent years because of the greater mechanization of operations, but this has been offset by increased employment in other activities (e.g., processing). Overall the direct employment per tonne of production has fallen from .047 to .045 person years per tonne over the 1993-1995 period.
- Most of the direct employment is on Vancouver Island, with the greatest concentrations of workers in Campbell River, Comox/Courtenay, Tofino and Port Hardy.
- The direct employment generated $36.6 million in wages and benefits in 1996. The average earning was $32,000, roughly equal to the average industrial wage in B.C.
- In addition to the direct impacts, the industry created an estimated 275 person years of employment in key supplier industries (e.g., feed distributors, marine transport, net and cage suppliers, and container and box suppliers). The total direct, indirect and induced impacts generated by the industry is estimated at almost 2,600 person years of employment.

- The industry generated about $4 million in government revenues in 1996. Over half of this was corporate income tax; the balance was property and capital taxes, business license fees, sales taxes and permit and license fees.

Impacts on Wild Salmon Prices

- Despite a decline in British Columbia wild salmon production, prices of B.C. wild salmon have fallen markedly in recent years. The decline in prices has been due to an increase in world wild salmon production (from an annual average of 706,000 tonnes over the 1986-90 period to 841,000 tonnes over the 1991-95 period) plus the marked increase in world farmed production (now over 550,000 tonnes).
- Farmed salmon competes effectively with wild salmon, in some cases commanding a price premium. World farm production has depressed fresh prices and displaced frozen markets.
- British Columbia farmed salmon alone, however, has had a relatively insignificant effect. B.C. production represents less than 5% of total world farmed supply and less than 2% of world farmed and wild supply combined. If B.C. farmed production were to disappear, any price impact would be short-lived as other countries which compete with B.C. (in particularly Chile) would likely expand their production and sales into the vacated markets.

Impacts due to Biophysical Effects

- Marine resources support a wide range of uses and economic activity—commercial fishing, sports fishing, marine tourism, subsistence economies. Any biophysical effects of salmon farming on these resources can consequently have significant economic and social impact.
- Biophysical effects on wild salmon resources could be very significant, requiring the foregoing of catch and/or enhancement of wild runs. The Technical Advisory Team (TAT) has concluded, however, that the likelihood of widespread impacts due to disease from fish farms is low—no such effects and consequent economic or social impact have been identified in B.C. to date. It is likely there will continue to be escapes and harvest of farmed fish and possible colonization in the wild, but this is not likely to have any significant economic consequences in terms of reduced quantity or value of wild catches.
- There are some impacts of salmon farming on other fishery resources. Generally the percentage of resources affected is small, but the impacts are very significant to individual and communities effected. The uptake of antibiotics by clams and other impacts on this resource is of particular concern to aboriginal communities because of their heavy dependence on and consumption of marine resources.

- A survey of marine tourism operators in the Broughton area indicates they are affected by salmon farming—mostly negatively, but in some cases positively. The marine tourism operators that were surveyed reported employing 271 persons, mostly on a seasonal basis. The estimated full time equivalent was 106 person years of employment, 31% of whom live in the Broughton area. Tourism activity has been growing rapidly—more than doubling over the past five years. While some indicate their operations could have grown even more rapidly, it would appear that despite the negative impacts, salmon farming has not significantly reduced economic activity in tourism businesses. It is more likely to have caused operators to find other routes or anchorages within the Broughton or to divert to other areas along the coast.
- Other impacts have been reported on upland property, archaeological resources and navigation and safety. Generally the impacts are small because of the remoteness of the sites, though again they are very significant to the individual affected. The extent of the impacts on archaeological resources is not well known because of the absence of site surveys prior to licensing.

Impacts on Study Area Communities

- Salmon farming and related activity in the Broughton area has generated 207 jobs, 21% of which (44 jobs) are held by residents in the Broughton study area. Most of these local workers reside in Port McNeill and work at the new local processing plant, and most originate from the area. There is some, but only minor indirect benefit to the study area communities from salmon farming purchases of services and supplies, as most of the supplies and services are provided from larger centres such as Port Hardy or Campbell River.
- Overall, the impacts on the study area communities are relatively small, accounting for only 2% of the total employment, but because of the predominately local hiring the jobs do provide some offset to declining resource industries and do offer some growth potential.

Impacts on First Nation Communities

- First Nations' communities depend heavily on marine resources for commercial fishing and for their subsistence economy. Overall, the impact of salmon farming on First Nations' communities has been negative. There have been adverse impacts on clam resources on which they depend; farms have been sited near their communities and in their traditional territories despite First Nations objections; and First Nation participation in the employment and business opportunities afforded by salmon farming has been very limited. Total employment from First Nations accounts for some 4% of the jobs in the study area and 5% of the salmon farming jobs created province-wide. Most of these are in processing or hatchery activity.

I. INTRODUCTION

In July, 1995, the Environmental Assessment Office (EAO) was requested to conduct a comprehensive review of the environmental risks associated with salmon farming and to evaluate the adequacy of current methods and processes to prevent or reduce adverse effects. In November of that year the terms of reference were amended to explicitly recognize socio-economic considerations in the overall review. The amended terms of reference were then released by the EAO for public comment.

Based on the amended terms of reference and public comments, the EAO concluded that social and economic analyses at a broad level were required to provide appropriate context for the review of existing operations and impacts, and for the assessment of any recommendations. As a result, the EAO commissioned this study with the following objectives:

(i) to identify the social and economic impacts of salmon farming as it currently exists in British Columbia; and

(ii) to assess the social and economic effects of the alternative regulatory and policy options to be considered in the second phase of the review.

The study was required to consider social and economic impacts in the Broughton Archipelago, but also the impacts of salmon farming on the province as a whole.

An outline of the proposed scope for the socio-economic study was presented to the Review Committee at its October, 1996 meeting in Campbell River. Basically it was proposed that the study address:

- the income, employment and government revenue impacts directly and indirectly generated by salmon farming activity;
- the income, employment and government revenue impacts directly or indirectly generated as a result of any biophysical or market effects of salmon farming on commercial fisheries;
- the impacts, commercial or otherwise, of salmon farming on other resource activities such as recreation and tourism, food fisheries, upland property use, marine transport;
- the significance of the positive or negative employment impacts on coastal communities' population and economic base;
- the specific impacts on native communities in terms of employment, resource use and other matters.

The scope of the study was generally accepted, but both at the Campbell River presentation and in follow-up communications, Review Committee members provided numerous comments and suggestions.

A number of comments emphasized the need to consider the nature of the benefits of salmon farming, including:

- the quality, stability and location of salmon farming jobs;
- supplier industry growth potential;
- benefits to commercial fishing through market development and greater utilization of processing facilities and supplier services;
- benefits to government from tax revenues and reduced unemployment insurance payments.

Others emphasized the need to consider the full range of costs and risks associated with salmon farming, including:

- adverse impacts on salmon, shellfish and other marine resources;
- habitat and resource restoration and potential compensation costs;
- health risks, both of a localized and global nature;
- adverse impacts on upland property owners, boaters and log salvagers;
- adverse impacts on salmon markets and prices for commercial fishers;
- costs to government in subsidies and unrecovered regulatory, monitoring and enforcement costs.

Some cited the need to look at factors affecting the size and distribution of benefits and costs, including:

- trends in labour requirements per unit of production;
- concentration of ownership, particularly by large multi-national firms;

- the potential resource conflicts of a large scale increase in operations, as some suggest could occur under a more permissive regulatory environment.

Aboriginal representatives raised a wide range of issues with respect to the effect of salmon farming on their communities. They emphasized the need to consider:

- concerns over impacts on fisheries resources and the commercial fishing industry that are so critical to their culture and livelihood;
- health concerns because of the extent of their reliance on shellfish and other marine resources in their diet;
- concerns over the intrusion into their traditional territories without their consent or without effective regulatory control;
- concerns over the limited participation by aboriginal people in salmon farming employment, leases or related business opportunities.

While not able to address every issue in detail, the study team recognized the validity of all of these comments. There are both positive and negative social and economic issues that must be considered. The overriding goal of this study has been to bring information to bear on all of these issues in order to provide some perspective to the nature, magnitude and significance of the positive and negative social and economic effects.

The data sources the study team has relied upon to do this include existing studies, surveys undertaken for this review and extensive consultation with persons involved with salmon farming, affected marine resources and affected communities. Surveys and interviews specifically undertaken and relied upon extensively for this review include:

- A survey of salmon farms conducted by Coopers & Lybrand on behalf of the BC Farmers Association (BCSFA) to update salmon farming activity and impacts in B.C. The thirteen salmon farming companies that are BCSFA members responded to the survey, representing an estimated 94% of total B.C. farmed salmon production. Coopers & Lybrand also collected data from processors and contractors directly involved in the industry.
- A survey of twenty-four key suppliers to the salmon farming industry by the Columbia Pacific Group and Coopers & Lybrand on behalf of the BCSFA to collect data on employment, wages and salaries and percentage of revenues attributable to the salmon farming industry.
- Interviews with salmon farming companies, contractors and selected suppliers operating in the Broughton Archipelago by Marvin Shaffer & Associates (MSA) for a case study of impacts in the study area.
- Interviews with economic development and community representatives in the Broughton Archipelago by MSA to collect information on the socio-economic importance of salmon farming in the study area.
- A survey of marine tourism operators by MSA and the BC Ministry of Small Business and Tourism to collect information on tourism activity and the impacts of salmon farming. Included in the survey were fishing lodges, marinas, charter boats, kayak and scuba operators, campgrounds and resorts.
- Interviews with salmon brokers, distributors and processors to collect information on salmon markets and the impacts of farmed production.
- Interviews with First Nation representatives and fishery biologist advisors by MSA to collect information on the nature and significance to First Nations of salmon farming impacts on marine resources.

The surveys conducted on behalf of the BCSFA were initiated primarily to provide data MSA requested for this review. MSA worked closely with the BCSFA consultants to design the questionnaires and had access to the raw data results. Additional interviews by MSA were undertaken to independently check the reasonableness of the results.

II. CURRENT SALMON FARMING ACTIVITY IN BC AND RECENT TRENDS

A. NUMBER OF FARMING COMPANIES AND GROW-OUT SITES

Salmon farming in British Columbia began in the late 1970s, with the Pacific Biological Station in Nanaimo conducting research on the farming of Pacific salmon. In 1980, 157 tonnes of salmon were produced from approximately four sites. Salmon farming expanded rapidly in the 1980s. By 1988 there were some one hundred companies operating 118 active salmon grow-out sites, with production of 6,590 tonnes.1

Between 1989 and 1991, 26 salmon farming companies went into receivership, representing over 25% of the industry. There were also consolidations of smaller firms. Price Waterhouse noted the following factors contributing to the business failures:2

• high debt/equity ratios;• high production costs;• environmentally poor sites (particularly on the Sunshine coast);• relative low prices (salmon prices declined over 30% between 1990 and 1992).

The industry consolidated further through the early 1990s, resulting in fewer firms, larger scale operations and a greater number of sites controlled by each firm. By 1993, there were only seventeen farming companies in the industry; by 1996, there were only sixteen different farming companies. The average number of active sites per company is now estimated at 4.94, more than double the average 2.27 sites per company in 1991 and more than quadruple the average 1.16 sites per company reported in 1988 (see Table 1).

Table 1—Number of Farming Companies and Grow-Out Sites

	1988	1991	1993	1996
Number of Salmon Farming Companies	101	na	17	16**
Number of Active Grow-Outs	118	na	88*	79***
Average Number of Sites per Company	1.16	2.27	5.18*	4.94

**May include some fallow sites.*
***Includes 13 companies that belong to the BCSFA and 3 non-BCSFA companies. This is less than the number of companies that the Ministry of Agriculture and Fisheries lists as holding licenses, but the Ministry list includes inactive companies and companies who have sold their licenses to others.*
****Includes 74 active sites of the 13 BCSFA member companies and 5 active sites for the 3 non-BCSFA companies. The total of 79 is less than reported elsewhere (e.g., by Ellis & Associates in Net Loss, October, 1996) but this estimate excludes non-active and fallow sites.*
Sources: Price Waterhouse (1993); ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies.

While the number of companies has changed by only one over the past three years, their average size has significantly increased. As shown in Table 2, there were fewer small companies (producing less than 1000 tonnes) and a greater number of large companies (producing over 2000 tonnes) in 1996 than reported in 1993.

Table 2—Distribution of Companies by Level of Production *(% of total number companies)*

Production level	1993	1996
Less than 500 tonnes	35.3	25.0
500 – 999 tonnes	23.5	18.7
1000 – 1999 tonnes	17.6	18.7
larger than 2000 tonnes	23.5	37.5
Total	100.0*	100.0

***Does not add due to roundingSource: ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies..**

The six largest salmon farming companies now account for over 70% of British Columbia's total farmed production. Most of these companies are large multi-nationals, with farming operations in other countries, as described below:

- **Heritage Salmon** [owned by B.C. Packers Ltd. (IAF)] is part of the Toronto based company Weston Foods Ltd. Heavily involved in the commercial salmon fishery, B.C. Packers is now one of the largest producers of farmed salmon in B.C. B.C. Packers diversified its production base into Chile with the purchase of Fiordo Blanco SA in October 1995 for a reported $10 million.3
- **Pacific Aqua Salmon Farmers** (owned by International Aqua Foods Ltd.) (IAF) is a Vancouver based company listed on the Toronto Stock Exchange. In B.C., IAF has sites in Tofino, Campbell River and the North Island. IAF has expanded in other jurisdictions through the purchase of Ocean Horizons S.A. in Chile in 1993, Maine Pride Salmon Inc. in 1995 and a hatchery facility also in the State of Maine in 1995.4
- **Omega Sea Farms Ltd.** is owned by Norwegian interests. Its operations are in the North Island and Port Hardy area.
- **Pacific National Group Ltd.** (Pacific National) is a Canadian-owned company based in Victoria, B.C. with operations in the Tofino area. The company also has a value-added processing plant in Washington State.
- **Paradise Bay Sea Farms** (Paradise Bay) is part of the Nutreco Aquaculture group of companies which has operations in Chile (Mares Austales, one of the major Chilean salmon farming operations) and Washington State (Aquastar). Nutreco is based in Holland and is at least partly owned by two large feed companies.5
- **Stolt Sea Farms Ltd.** is a subsidiary of the Norwegian multi-national Stolt-Nielson A/S, which also has operations in Norway, Chile, New Brunswick and Maine.

In addition to the greater concentration of activity by multi-site, multi-national farms, there has been a marked shift in the location of farms in British Columbia. Most noticeably there has been a trend away from the Sunshine Coast to other areas (see Table 3). The Sunshine coast has proven to be less environmentally suitable for grow-out operations than other areas.

Table 3—Distribution of Active Grow-Out Sites by Regional District *(% of total number of active sites)*

	1993	1996*
Alberni-Clayoquot	17	23
Comox-Strathcona	25	35
Mount Waddington	28	27
Nanaimo, Cowichan, Capital	0	10
Sunshine Coast & Powell River	30	5
Total	**100.0**	**100.0**

**Based on the site distribution of BCSFA member companies included in the Coopers Lybrand survey, and the non BCSFA farms. Source: ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies..*

B. VERTICAL INTEGRATION

Salmon farming involves the following activities:

- lake rearing or land base hatchery;
- salmon grow-out;
- marine transport;
- processing; and
- marketing and distribution.

There is considerable vertical integration among the salmon farming companies. As shown in Table 4, of the 13 grow-out companies responding to the recent Coopers & Lybrand survey, all were involved in some of the other levels of activity; a number were involved in most.

Table 4—Salmon Farming Company Activities

	Transport	Processing	Marine Selling		Hatcher	Grow-Out
Agri-Marine		**X**	**X**			
Blue Tornado Enterprises		X				
Creative Salmon		X	X			
Heritage Salmon (BC Packers)	X	X			X	
Liard Aquaculture		X				
Nor Am Aquaculture	X	X	X	X		
Omega Salmon Group	X	X				
Pacific Aqua Salmon Farmers	X	X		X	X	
Pacific National Group	X	X	X	X	X	
Paradise Bay Seafarms	X	X				
Stolt Sea Farm	X	X			X	
Sunderland		**X**				
Target Marine Products	X	X	X	X		

Source: Coopers & Lybrand (1997).

The activities that the salmon farms do not undertake for themselves are contracted to other firms. The major salmon farming contractors to the B.C. industry and the services they provide are shown in Table 5. All of the firms listed in Table 5 were included in the recent Coopers & Lybrand survey of the industry.

Table 5—Contractors to Salmon Farming Companies

	Transport	Processing	Marine Selling		Hatcher	Grow-Out
Alpha Processing Ltd.				X		
Brown's Bay Packing Co. Ltd.				X		
Cansalm				X		
Long Beach Fisheries				X		
Saltstream Engineering		**X**				
Sea Agra Seafood Brokerage					X	
Sea Spring Salmon Farms Ltd	X					
Seafinn Marine Services Ltd.			X			
Transmar Shipping Ltd.			X			
Walcan Seafood				X		
West Coast Fishculture	X					

Source: Coopers & Lybrand (1997).

C. PRODUCTION

British Columbia farmed salmon production has increased sharply over the past ten years. Production levels are now in excess of 25,000 tonnes. This compares to some 13,500 tonnes in 1990 and less than 1,000 tonnes in the mid-1980s. (see Figure 1)

Figure 1—B.C. Farmed Salmon Production, 1985-1996*

**The 1996 estimate includes production from 3 non-BCSFA farms plus the BCSFA farm total in the Coopers & Lybrand survey. The chinook total for 1996 includes small amounts of coho production, as the Pacific salmon split was not available for that year.*
Source: Kenney (1996); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies.

Figure 1 illustrates not only the increase in total production, but also the marked shift in the species mix. Initially, B.C. producers attempted to grow coho and chinook, but that proved difficult because of high mortality rates and low rearing densities. B.C. farmers began experimenting with raising Atlantic salmon in the mid 1980s and found it to be more economic. According to industry representatives, B.C. farms are successfully rearing Pacific salmon, but production of Atlantics is generally preferred and increasing rapidly. Indeed, as shown in Table 6, Pacific salmon production fell about 26% between 1993 and 1996, while Atlantic salmon production grew by over 50%.

TABLE 6—Farmed Salmon Production by Species *(tonnes)*

	1993	1996*	% Change
Pacific	11,435	8,450	-26.1
Atlantic	11,300	17,050	+50.9
Total	22,735	25,500	+12.2

**The 1996 estimate includes production for 3 non BCSFA farms plus the BCSFA farm total in the Coopers & Lybrand survey.Source: Kenney (1996); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies..*

D. PRODUCT FORM, MARKET DESTINATION, AND MARKET SHARE

Traditionally the bulk of B.C. farmed salmon has been marketed fresh, head-on. Very little is intentionally frozen. In 1991, an estimated 95% of total production was sold fresh, head-on; the balance head-off or filleted. Recently, however, there has been a shift to value-added products, primarily fillets, in both fresh and frozen forms. Apparently this shift is attributable to a demand for more consumer friendly, table-ready seafood products by US buyers.

In 1995, an estimated 15% of B.C. farmed salmon production, by weight, was processed into value-added products and marketed into the US.6 While this represents an increase in value-added processing for B.C. growers since 1991, it still is much less than the proportion of Chilean production, a major source of competition to B.C., that is valued-added. In 1995 an estimated 40% of Chilean farmed salmon exports were sold in value-added forms.7

British Columbia producers are attempting to respond to the shift in buyers' preference for consumer-ready products by placing more emphasis on secondary processing. However, because filleting is a very labour-intensive activity, they are constrained by the high labour costs in this province, which makes it difficult to compete with Chilean producers in value-added product forms. Some B.C. companies attempt to reduce their processing costs by sending their salmon to Washington State for filleting, where labour costs are lower than in B.C.8

The British Columbia farming industry relies heavily on export markets for its sales. In 1995, almost 84% of B.C.'s farmed salmon production was exported, primarily to the U.S. and to a much lesser extent Japan and other Asian countries. The Canadian domestic market accounted for 16% of total B.C. sales.

As shown in Table 7, the Pacific Northwest and California account for the majority of the U.S. sales. California is the largest single market destination for B.C. farmed production. Similarly, British Columbia accounts for the majority of domestic market sales. Almost 11% of B.C. farmed production was sold within the province.

Table 7—Geographic Market Destination of BC Farmed Salmon Sales 1992 and 1995 (% of Total Production)

	1992	1996*	% Change
CANADA			
B.C.	**5.8**	**10.9**	
Other Provinces	9.5	5.6	
Subtotal	15.3	16.5	+1.2
UNITED STATES			
Pacific Northwest	18.5	19.4	
California	25.6	31.7	
Central/Mountain	18.3	15.5	
Atlantic	13.7	2.0	
Subtotal	**76.1**	**68.6**	**-7.5**
JAPAN, OTHERASIAN	8.6	14.9	+6.3
Total	**100.0**	**100.0**	

1992 B.C. Production = 17,500 tonnes. 1995 B.C. Production = 23,822 tonnes. Source: Kenney, (1996).

While the U.S. remains the largest market for B.C. farmed salmon, it has become increasingly competitive. Both Chile and Norway have increased their sales into the U.S. market, eroding B.C.'s share most notably in central and eastern markets. B.C. producers have looked increasingly to Japan and, to a lesser extent, to China and Korea to offset the increased competition and loss of market share in the U.S. Even in those markets, however, B.C. producers are facing strong competition. Chile in particular has been more successful than Canadian producers in establishing itself in the large Japanese seafood market. For example, while B.C. farmed salmon exports to Japan grew by 1,000 tonnes between 1993 and 1995, Chilean exports to Japan grew by 23,000 tonnes.9

Overall, British Columbia's share of world farmed salmon production has been declining since the early 1990s. Table 8 shows farmed production by country for 1988 and 1995. While B.C.'s production increased significantly, the 17,000 tonne increase in B.C. is relatively minor compared to the 170,000 tonne increase in Norway, 123,000 tonne increase in Chile, and 47,000 tonne increase in the U.K. over that period. By 1995 B.C.'s market share had fallen to 4.3%. As shown in Table 9, this is B.C.'s lowest market share over the entire 1988-95 period—almost 40% less than British Columbia's peak market share of 6.8% in 1991.

9 Kenney (1996)

TABLE 8—World Production of Farmed Salmon, 1988 and 1995

	1988 Production		1995 Production	
	'000 tonnes	% share	'000 tonnes	% share
Norway	**80.3**	**57.5**	**251.0**	**45.5**
Chile	3.1	2.2	126.3	22.9
United Kingdom	17.6	12.6	65.0	11.8
British Columbia	6.6	4.7	23.8	4.3
Ireland	4.2	3.0	16.0	2.9
Eastern Canada	3.3	2.4	14.7	2.7
United States	2.0	1.4	14.7	2.7
Japan	14.1	10.1	14.1	2.5
Faeroe Islands	3.4	2.4	12.4	2.2
Other Countries	5.1	3.7	13.9	2.5
Total	**139.7**	**100**	**551.9**	**100**

Source: Price Waterhouse (1993); Kenney (1996).

TABLE 9—B.C.'s Share of World Market Production of Farmed Salmon 1988 and 1996

	BC Production		World Production
	tonnes	%	tonnes
1988	6,590	4.7	139,680
1989	**11,883**	**5.7**	**209,700**
1990	13,512	4.7	286,550
1991	21,318	6.8	311,475
1992	17,506	5.7	306,822
1993	22,765	6.1	370,966
1994	20,389	4.6	448,417
1995	23,822	4.3	551,911

Source: Price Waterhouse (1993) and Kenney (1996).

E. COMPETITIVE STRENGTHS AND WEAKNESSES OF BC FARMED SALMON INDUSTRY

The B.C. salmon farming industry has several strengths and weaknesses that bear on its competitiveness with other producing regions.

The major strengths of the B.C. industry are its location, excellent growing conditions and technical expertise. Because of its proximity to the large and growing U.S. market, particularly the U.S. westcoast, the B.C. industry faces lower transportation costs than its principal competitors. The B.C. industry also has transportation advantages in serving the emerging Asian markets. The increasingly efficient air links between Vancouver and Asian Pacific Rim countries has resulted in B.C. being several hours closer in travel time, giving B.C. producers some advantages in terms of delivering fresh product with longer shelf life to this market.

B.C. has excellent growing conditions for both Atlantic and chinook salmon, with an abundance of potential sites. There is, consequently, the potential for increasing production capacity well beyond current levels without having to move to higher cost locations.

Finally, the B.C. industry has the technical expertise, skilled labour force and sales capacity to enable it to compete effectively with other suppliers.

The principal weaknesses of the B.C. industry are factors contributing to higher costs. Labour and feed costs are considerably higher than in Chile, B.C.'s principal competitor in the U.S. and Japanese markets. While B.C has invested in more mechanized processes to offset the labour cost disadvantage, a differential in feed cost still remains. Feed is the single largest cost factor in grow-out operations.

Also, while B.C. has achieved some economies of scale in recent years, it has not done so to the same extent as its major competitors, where output levels are much higher. This has adversely affected grow-out, processing, marketing and administrative costs relative to the large producing countries.

F. FINANCIAL PERFORMANCE

The salmon farming industry performed poorly in the late 1980s and early 90s due to relatively high costs and falling salmon prices. This led to widespread business failures and consolidation of smaller firms.

With the increased scale and concentration of activity since the early 1990s, financial performance has steadily improved. As shown in Table 10, salmon farming gross income (profits before depreciation, interest and taxes) increased from $15.7 million in 1993 to over $30 million in 1995 and 1996. There was a slight decline between 1995 and 1996, due primarily to lower world prices.

TABLE 10—Financial Performance of the B.C. Salmon Farming Industry ($ Million)

	1993	1995	1996
Total Farmed Salmon Revenues:		168.9	167.2
Selling Expenses:		(6.1)	(6.1)
Total Revenues Net of Selling Expense:		**162.8**	**161.1**
Operating Costs (Net of other revenues):		(120.0)	(120.5)
Gross Margin:		42.8	40.6
General and Administrative Expenses:		**(10.7)**	**(9.3)**
INCOME (before depreciation, interest and taxes):	15.7	32.1	31.3

Source: ARA (1994); Coopers & Lybrand (1997).

The increased profitability in recent years has been due to lower operating costs and more efficient operations. A major factor in this regard has been a shift to more mechanized operations and consequent improvement in labour productivity. In 1993, the average fixed capital investment per unit of production was $1,178/tonne. That had increased to $1,835/tonne by 1995, and to $2,081/tonne by 1996. Labour requirements per unit of production have correspondingly decreased, particularly for grow-out operations, with a reduction of over 15% over the past three years.

Other factors contributing to lower costs include a reduction in smolt costs. In the early 1990s there was a shortage of smolts, causing upward pressure on prices. With expanded hatchery capacity, smolt prices have come down. The economies of scale that the industry has achieved have also contributed to lower costs. Administrative costs in particular have fallen in recent years. Finally, the shift to Atlantics, with their higher yields and growing density, has served to reduce costs and increase profitability.

In addition to the reduction in costs, there has been a shift to higher valued products. These generate more revenues for the industry but they also give rise to additional costs. The net effect on profitability is not yet clear.

G. ROLE OF GOVERNMENT

The provincial and federal government has generally supported the growth of the salmon farming industry. In the early years of its development, there was direct support (grants and loan programs) to salmon farming companies as well as extensive government-funded research and development.

In recent years, government support has been much reduced. There are no direct grants or loan programs available to the salmon farming industry. The only government support that salmon farmers directly benefit from is investments through the Venture Capital Corporation—an entity that provides tax credits to investors. Such investments totalled $2.5 million in 1996 yielding tax credit benefits of some $750,000. No investments through this corporation are expected in 1997.

Indirectly, government still supports the industry through research and development, promotion, financial contributions to industry associations, and unrecovered regulatory costs. As shown in Table 11, these were estimated to total $4.05 million in 1996, or roughly 2.4% of the value of B.C. farmed salmon sales. This compares to an estimated average level of support of 8% of farm revenues in other agricultural industries in B.C.10 It is also considerably below, in both percentage and absolute dollar terms, the level of support directly and indirectly provided to the commercial salmon fishing sector through, for example, the salmonid enhancement program, fisheries regulation and management, small craft harbours and other services or contributions.

TABLE 11—Indirect Government Support to the B.C. Salmon Farming Industry 1996 ($ Millions)

FEDERAL GOVERNMENT	
Fisheries & Oceans (DFO)	
- Salmon Farming Research development and Promotion	2.5
PROVINCIAL GOVERNMENT	
Ministry of Agriculture, Fisheries and Food	
- Aquaculture and Commercial Fisheries Branch	1.16
- Partners in Progress	.06
Ministry of Environment, Lands & Parks	
- BC Lands	.1
- Waste Management	.23
TOTAL	**4.05**

Source: Based on estimates from DFO, Ministry of Agriculture, Fisheries and Food; and Ministry of Environment Lands & Parks.

While the indirect financial support for salmon farming has contributed to the growth of the industry, a number of regulatory policies have had the opposite effect. The moratorium that the B.C. government has imposed on new leases has restricted the growth of the industry, led to higher than optimal densities at existing sites and less than optimal fallowing of sites. Uncertainty over future regulations and coastal planning processes has also adversely affected investment and growth of the industry.11

III. ECONOMIC IMPACTS

Salmon farming activity can have both positive and negative economic effects. The positive impacts derive from farmed salmon production and the employment income that generates. Negative impacts can occur as a result of the effect that farmed salmon sales have on market prices for wild salmon and as a result of the biophysical effects that farming salmon has on marine resources and the various activities—commercial and sport fishing, subsistence economies, recreation and tourism, upland property use, boating—that depend on them. The nature,

extent and significance of the positive and negative impacts resulting from current salmon farming operations are discussed below.

A. IMPACTS FROM FARMED SALMON PRODUCTION AND SALES

The production and sale of B.C. farmed salmon generated an estimated $167.2 million in revenues in 1996.12 As noted earlier, these generated a gross income (profit before depreciation, interest and incomes taxes) of $31.3 million. The balance of the revenues paid for operating, sales and administration costs, as shown in Table 12. The operating, sales and administration costs include expenditures for labour and a wide range of goods and services, giving rise to the direct and indirect income and employment impacts, as discussed below.

Table 12—1996 Farmed Salmon Revenues and Income/Expenditure Breakdown* ($ Millions)

TOTAL FARMED SALMON REVENUES	**167.2**
Operating Expenses	
Hatchery	19.7
Grow-Out	85.6
Harvesting	6.6
Processing	17.1
Shipping	2.6
Less Other Revenues;	(11.1)
Net Operating Expenses:	**120.5**
Other Expenses	
Sales	6.1
Administration	9.3
Total Other:	**15.4**
Other Expenses	**135.9**
Income (Before Depreciation, Interest & Income Taxes)	**31.3**

***Based on Coopers & Lybrand survey of BCSFA member companies. Excludes revenues and expenditure for 3 non BCSFA firms, which account for 6% of total B.C. production. Source: Coopers & Lybrand (1997).**

Direct Employment Impact

For purposes of this study, direct employment impacts refer to the number of person years (PY) of employment (i.e. number of jobs adjusted to full time equivalent) in the salmon farming company operations and in the hatchery, grow-out, harvesting, marine transport and sales activity of contractors to the salmon farming companies. Direct impacts exclude employment in companies supplying goods (e.g., feed and equipment) or services not involving the handling of live fish (e.g., freight).

In Table 13, the direct employment impacts from salmon farming, defined in this manner, are shown for 1993 and 1996. Total direct employment is estimated at 1,142 person years in 1996, a slight increase from 1993. Employment in grow-out operations has actually fallen, but this has been offset by growth in processing and transport jobs. Overall, employment per unit of production has fallen, reflecting the increasingly mechanized nature of the operations.

Most of the jobs in the salmon farming industry are full time because of the year-round nature of the operations. However, there are some part-time and casual jobs. As a result there are more people working in the industry than the number of person years of employment suggest. Based on the Coopers & Lybrand survey, there are 16% more jobs than person years of employment directly generated by the industry.

Table 13—Salmon Farming Direct Employment

	1993	1996*
Hatchery	126	124
Grow-Out Sites	522	496
Processing	**266**	**332****
Transport	63	78
Selling and Administrative	96	87
Other		25
Total Direct Employment	1,073	1,142
PYs per tonne of fish produced	.047	.045

The 1996 estimate includes employment of three non-BCSFA firms as well as the BCSFA firms and contractors included in the Coopers & Lybrand survey. Excludes employment at the recently completed Engelwood plant in Port McNeill which began operating in December 1996 and employs about 40 people.Source: ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies..*

Tables 14 and 15 show the distribution of employment by location of employee residence. As shown in the Tables, much of the employment is concentrated in Campbell River and Comox/Courtenay areas. Indeed about 50% of the total direct employment is for workers who reside in the Comox-Strathcona regional district. There has been a shift away from employment in the Sunshine Coast and Powell River area, reflecting the shift in the location of production that has taken place in recent years.

Table 14—Direct Employment by Community (person years)

	1993	1996*
Campbell River	278	425
Comox/Courtenay	62	115
Tofino	66	98
Port Hardy	47	84
Port Alberni	80	64
Ucluelet	24	56
Powell River	85	37
Port McNeill	17	28**
Nanaimo	**25**	**16**
Sechelt	87	14
Other Non-urban	215	132

Greater Vancouver and Victoria	87	73
Total	**1,073**	**1,142**

The 1996 estimate includes employment of three non-BCSFA firms as well as the BCSFA firms and contractors included in the Coopers & Lybrand survey. Excludes employment at the recently completed Engelwood plant in Port McNeill which began operating in December 1996 and employs about 40 people.Source: ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies).*

Table 15—Direct Employment by Regional District (person years)

	1993	**1996***
Alberni-Clayoquot	192	226
Comox-Strathcona	446	582
Mount Waddington	85	130**
Nanaimo, Cowichan & Capital	36	82
Sunshine Coast & Powell River	**231**	**68**
Greater Vancouver Regional District & Other BC	83	54
Total	**1,073**	**1,142**

The 1996 estimate includes employment of three non-BCSFA firms as well as the BCSFA firms and contractors included in the Coopers & Lybrand survey. Excludes employment at the recently completed Engelwood plant in Port McNeill which began operating in December 1996 and employs about 40 people.Source: ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies..*

The employees are generally hired from the local areas. In most aspects of the industry, turnover rates are low and job satisfaction high. The major companies report very stable work forces, particularly for more senior positions. Turnover for entry level positions, however, is much higher. Turnover is highest at remote grow-out sites, because of the long shifts at those operations.

Wages for farming industry workers vary by position. Farm and hatchery workers generally earn between $9 and $15 per hour; processing employees between $9 and $12 per hour; supervisory workers between $12 and $20 per hour; managerial workers between $15 and $20 per hour and senior management in excess of $20 per hour.13 In Table 16, the total wages and benefits earned by those directly employed in the industry are shown. They totalled $33.8 million in 1993 and $36.6 million in 1996. The average earnings per employee were between $31,000 and $32,000 in both years, roughly equal to the average earnings across all industries in British Columbia.14

Table 16—Wages and Salaries from Direct Employment

	1993	**1996***
Total Wages and Benefits (millions)	33.8	36.6*
Per PY of Employment	31,500	32,000

**Includes estimated wages and benefits for the 3 non-BCSFA firms as well as the BCSFA firms and contractors in the Coopers & Lybrand study. Source: ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies..*

Indirect Employment Impacts

In addition to the direct employment, the salmon farming industry generated employment in other industries as result of the goods and services it purchases.

Feed is the single largest industry purchase, accounting for almost 40% of total production expenditures in 1996.15 There are three large feed suppliers in the Lower Mainland:

- Ewos Canada Ltd., part of the Cultor group of companies based in Finland.
- Moore-Clark, a subsidiary of BP Nutrition, and
- Pro Form.

Two of these suppliers rely heavily on salmon farming purchases as a source of revenue; for the other supplier, salmon farming purchases are a minor revenue source. Ewos and Moore-Clark control approximately 90% of the fish feed industry.

The industry also relies heavily on marine transport, with significant purchases of marine towing and barging services, marine supply, boats, engines and related services. Suppliers of marine transport services to the salmon farming industry include:

- Alert Bay Towing and barging
- Beaver Aquatics, marine supply
- Daigle Welding, custom aluminium boat manufacturer
- Larsen Diesel, engine sales and service, hydraulics, welding
- North Island Marine, marine sales and services
- Tidemark Marine, anchoring, construction and towing
- Vick Enterprises Ltd., marine industrial equipment

For five of these suppliers, purchases by salmon farmers represents between 10% and 25% of revenues. For the marine towing and transportation companies, the percentage is higher, between 45% and 100%.16

Major suppliers to the processing plants include containers and box manufacturers. According to industry representatives, a large processing company can require as many as one truckload of Styrofoam boxes for each two shifts of processing. One of the producers of containers, Aqua-Pak Styro Containers (Aqua-Pak) from Vancouver, started in 1986 as a result of the salmon farming sector.

Aqua-Pak in Vancouver and Noboco Products (Noboco) in Campbell River produce Styrofoam boxes for the aquaculture sector. Together the companies employ 48 full-time employees. Noboco remains 100% linked to the aquaculture sector but Aqua-Pak has now diversified into many other packaging products. Among other products, Aqua-Pak now supplies packaging materials for shipping sea urchins, geoducks and wild mushrooms to Japan and other countries. Aqua-Pak and Noboco in turn have a large number of suppliers. For example, Bulldog Bag, a sheet plastic manufacturer, supplies bags to Aqua-Pak and Noboco, and also to the feed manufacturers for packaging feed.

Capital expenditures by the salmon farming industry totalled $16.4 million in 1996, an increase of over 30% from 1995. As shown in Table 17, nets, cages and equipment accounted for the majority of the capital expenditures.

Major net manufacturers include:

- Cards Aquaculture Products, manufacturer of nets, cages and mooring systems
- Campbell River Net Lot, a net cage manufacturer; and
- Quadra Net Service, net loft and related services.

Equipment suppliers include McTavish Welding which produces automatic feeding machines. Other suppliers include PRA manufacturing, a manufacturer of fish pumps and Sea R. Power, a manufacturer of marine equipment supplies.

Table 17—B.C. Salmon Farming Industry Campital Expenditures in 1995 and 1996 ('000s)

	1995	1996
Nets	2,534	3,347
Cages	2,844	3,750
Barges	**888**	**1,173**
Boats	826	1,091
Trucks	58	77
Equipment	2,823	3,729
Buildings	1,232	1,627
Other	1,195	1,579
Total	**12,400**	**16,373**

Source: Coopers & Lybrand (1997).

Coopers & Lybrand and the Columbia Pacific Group conducted a survey of twenty-four key suppliers to the salmon farming industry, including the firms listed above. Each supplier provided data on employment and the percentage of revenues derived from salmon farming. Based on that information, the amount of employment dependent on the salmon farming industry was estimated.

In Table 18, employment estimates for key suppliers is shown, broken down by residence of employee, along with the direct impacts. As shown in the table, key supplier employment dependent on the salmon farming industry is estimated to total 275 person years. Over half of this employment is located in the GVRD; one-quarter is located in the Comox-Strathcona regional district.

Table 18—Direct and Key Supplier Employment by Regional District, 1996 (person years)

	Direct	Key Suppliers**	Total	
Alberni-Clayoquot	226	6	232	
Comox-Strathcona	582	70	652	
Mount Waddington*	130	5	135	
Nanaimo, Cowichan & Capital	82	18	100	
Sunshine Coast & Powell River	68	25	93	
Greater Vancouver Regional District &Other British Columbia		54	151	205
Total	**1,142**	**275**	**1,417**	

**The direct employment data exclude the Engelwood Packing plant in Port McNeill which opened in December, 1996.*

****Includes only the suppliers that responded to the survey. Generally, these tend to be suppliers that heavily depend on the salmon farming sector. Others that are not linked directly to the salmon farming such as suppliers of fuel, general supplies, etc. were not included in the survey. Employment at key suppliers excludes contractors such as contract processing plants, contract marine transport, hatchery and smolt production. These are considered part of the direct employment.**

The key supplier employment shown in Table 18 does not include all of the indirect effects. It does not include the employment generated by other suppliers to the salmon farming industry, nor does it include the employment generated in industries directly and indirectly providing goods and services to the supplier industries. Based on an input-output analysis of the operating expenditures of the salmon farming industry, it is estimated that the total person years of employment directly and indirectly generated in B.C. by the industry in 1996 was 2,083. The respending of the income earned by these people is estimated to induce a further 504 person years of employment, resulting in a total annual impact of 2,587.17

Government Revenue Impacts

In Table 19, the government revenues from the corporate taxes and license fees paid by the salmon farming industry are shown. The table does not include the taxes paid by salmon farming industry employees nor the unemployment insurance or other savings due to the employment created by the industry.

Table 19—Corporate Taxes and Other Payments ($ Millions)

	1993	1996
Corporate Income Taxes	--	2.29
Property Taxes	0.2	0.24
Capital Taxes	**0.2**	**0.35**
Business Licenses	not included	0.03
Provincial Sales and Other Taxes	not included	0.65
Other Taxes	not included	0.02
Federal Aquaculture Permits and Licenses	in provincial	0.06
Provincial Aquaculture Permits and Licences	0.04	0.34
Total	**0.08**	**3.97**

Source: ARA (1994); Coopers & Lybrand (1997).

As shown in the table, taxes and fees paid by the industry are relatively small. In 1993, the taxes and fees totalled less than $1 million. In 1996 that increased to $4.0 million, the increase in large part due to the payment of some corporate income taxes in that year. No corporate income taxes were paid in 1993 because of the carrying forward of previous losses.

B. IMPACTS OF FARMED SALMON SALES ON WILD SALMON MARKETS

British Columbia's wild salmon production has been declining in recent years. Average annual production of wild salmon in B.C. was some 69,000 tonnes over the 1991-95 period, as compared to over 88,000 tonnes in the previous 1986-1990 period.14 In Table 20, B.C. wild salmon production is shown by year from 1991–1995. The table shows the marked decline in recent years, particularly for coho and chinook, the two wild salmon species that compete in the market place most directly with farmed salmon.

Table 20—B.C. Salmon production by species, 1991–1995 (tonnes)

	1991	1992	1993	1994	1995
Sockeye	25,200	20,600	42,529	30,810	9,989
Pink	35,100	14,700	16,046	3,383	18,392
Chum	10,200	17,500	17,274	20,247	8,736
Chinoook	5,100	5,300	4,817	3,574	1,240
Coho	10,100	7,300	4,316	7,712	4,039
Total	**85,700**	**65,400**	**84,982**	**65,726**	**42,396**

Source: Kenney (1996).

Despite the reduction in B.C. supply, and growth in consumer demand, prices for B.C. wild salmon have fallen sharply over the past ten years. Table 21 shows fresh and frozen wild salmon prices from 1985 to 1996. Prices in 1996 for all species except sockeye are 30% to almost 50% below what they were in 1985. The real decline in prices, taking the general rate of inflation into account, would be even more pronounced.

Table 21—Wild salmon prices ($/Kg)

	Chinook		Sockeye		Coho		Pink		Chum		Fresh Frozen
	Fresh	Frozen	Fresh	Frozen	Fresh	Frozen	Fresh	Frozen			
1985	**7.89**	**9.78**	**6.87**	**7.52**	**5.79**	**6.84**	**2.73**	**3.11**	**3.14**	**3.93**	
1986	6.46	7.87	8.11	8.63	5.74	6.68	2.74	3.13	2.72	3.77	
1987	9.00	9.58	9.05	10.40	7.32	8.52	3.79	4.26	4.70	5.35	
1988	9.42	12.56	11.87	14.27	6.87	10.63	3.76	5.52	5.18	6.01	
1989	6.04	7.65	7.62	9.04	4.36	5.40	2.70	3.14	3.39	3.78	
1990	**6.22**	**7.15**	**6.64**	**8.07**	**4.27**	**6.11**	**2.82**	**2.85**	**3.41**	**3.75**	
1991	5.70	7.63	6.33	7.28	4.10	5.76	2.19	2.44	3.92	3.30	
1992	5.70	7.94	8.22	8.20	4.51	5.79	2.21	2.49	2.84	3.44	
1996	**5.18**	**6.83**	**7.16**	**7.72**	**4.30**	**5.18**	**1.54**	**2.20**	**1.76**	**2.20**	

Source: BC Ministry of Agriculture, Fisheries & Food for 1985-92; industry sources for 1996.

It is world market conditions that govern the prices B.C. producers receive for their salmon. In both domestic and export markets, B.C.'s prices must be competitive with alternative sources of supply. It is because of that dependence of world market conditions, and what has happened on the world markets, that B.C. prices have fallen.

Firstly, as shown in Table 22, despite the decline in B.C. wild salmon production, world wild salmon production has significantly increased. B.C. is the smallest of the four world producers of wild salmon. The U.S. is the largest producer, followed by Japan and Russia. Much of the U.S. and Japanese production is enhanced—ocean ranched salmon from government funded and operated hatcheries. These supplies and production from Russia have increased, more than offsetting the decline in B.C. production over the past ten years.

Table 22—World production of wild salmon (tonnes)

	Annual Average 1991-1995	%	Annual Average	%	1986–1990
United States	303,520	43.6	388,715	46.2	
Japan	193,679	27.4	211,533	25.1	
Russia	119,935	17.0	172,321	20.5	
British Columbia	**88,580**	**12.6**	**68,841**	**8.2**	

Total	705,714	100.0	841,410	100.0

Source: Kenney (1996)

In addition to the increase in world wild salmon production, there has been a large increase in farmed salmon production. In 1995, world production of farmed salmon was 552,000 tonnes, as compared to 286,000 tonnes in 1990 and less than 140,000 tonnes in 1988. That large increase—over 400,000 tonnes in the last seven years—has significantly affected all salmon prices, particularly fresh and frozen forms.

Wild coho and chinook directly compete with farmed salmon. According to distributors active in the Canadian domestic and western US markets, up to about three years ago, wild coho and chinook were preferred over farmed fish. Thus sales and prices of farmed salmon tended to fall during the summer and fall months. With the continuing decline in wild coho and chinook supply from BC and the US, however, as well as improvements in the overall quality and size consistency of fresh farmed salmon from producers in all countries, there has been a substantial shift in buyer preferences. Farmed fish now command prices equal to or greater than fresh wild coho and chinook even during the peak wild salmon harvesting season. The year round availability of fresh farmed salmon has also reduced the demand for frozen wild coho and chinook, as many users have shifted from purchasing inventories of frozen wild salmon for processing during the off-season, to buying fresh farmed salmon on an as-required, just-in-time basis. These shifts in buyer preferences have caused wild coho and chinook prices to decline even though total supply of these species has also fallen.

Sockeye is a high valued species which traditionally was sold in canned form both domestically and in the U.K. and Australian markets. However, a large share of sockeye has been sold frozen in Japan. Farmed salmon, particularly farmed coho from Chile, has been displacing B.C. sockeye sales into this market, diverting sockeye to smoked and other markets. Overall, the erosion of the Japanese market has had some adverse effect on price.

Chum and pink are low-valued species, largely canned, but also sold in fresh and frozen forms. Prices for these species have also fallen as fresh and frozen wild markets are eroded by increasing quantities of farmed salmon. The year round supply of fresh farmed fish diminishes the demand for and price of frozen salmon. This, in turn, increases the proportion of wild salmon sold fresh, depressing the in-season price. For example, the smoker market in Europe for frozen chums has largely been displaced by Norwegian farmed salmon. This has significantly affected fresh and frozen chum prices.

In sum, the sharp increase in farmed salmon production, combined with the increase in world wild salmon production, underlie the decline in B.C. wild salmon prices. However, it is important to distinguish between the effect of world farmed salmon production and farmed salmon production in B.C. B.C. farmed salmon production accounts for less than 5% of the world total—less than 2% of the total world farmed and wild production combined. By itself, B.C. farmed production is having a relatively minor effect. Put differently, if B.C. farm production were to disappear, there would only be a minor impact on prices, and even that would be short-lived as other farming nations increased their supply to take advantage of the vacated B.C. markets.

B.C. farmed salmon does have some positive impact on the wild commercial industry in the processing sector. While most farmed salmon is processed (gutted) in facilities exclusively serving nearby farms, some primary and secondary value-added processing is undertaken by custom processors who serve both the farmed and wild fishery.

One custom processor in Richmond reported that farmed salmon processing activities accounted for between 15% and 20% of total sales in 1996, a substantial increase over previous years. This processor stated that activities related to farmed salmon help to maintain business activity during the traditionally slow winter and spring months when wild salmon is not available, making this business more profitable and stable as a result. Again, however, because of the relatively small amount of such processing, the impact is relatively small.

C. IMPACTS FROM BIOPHYSICAL EFFECTS ON MARINE RESOURCES

The marine resources of British Columbia support a wide range of uses and economic activity. The commercial fishing industry generated $780 million in revenues in 1995.19 The sports fishing industry generated some $360 million in revenues; other marine tourism $75 million.20 Fisheries and other marine resources are critically important to coastal First Nation subsistence economies in providing food (salmon, groundfish, herring and herring roe, shellfish, marine mammals) and supporting their traditional culture and community activity. Marine resources are particularly important in more remote First Nation communities because of the high transport cost of store bought goods.21

Any biophysical effects of salmon farming on fisheries, tourism or other resources (e.g., upland property, archaeological resources, navigation) can consequently have significant economic and social impact. The extent to which this has occurred or can be expected as a result of the current level and nature of salmon farming activities is outlined below. The assessments are based on the more detailed findings of the Technical Advisory Team (TAT) on biophysical effects (see References) and on survey or other information on resource use.

Wild Salmon Resources

The major potential impacts of salmon farming on wild salmon resources relate to the introduction and transfer of disease, competition and colonization in the wild of escaped farmed fish, and genetic weakening due to interactions between wild and escaped farmed fish.

With respect to disease, the TAT has concluded that there is a very low probability of exotic disease affecting indigenous wild stocks due to the importation of Atlantic salmon eggs, given current policies and practices (e.g., disinfecting, quarantining, testing of eggs). If there were an outbreak of disease, the greatest impacts would most likely be on the farmed industry itself. However, wild stocks could also be threatened, particularly if they were stressed by other factors.

There may be a greater probability of indigenous diseases being transferred from farmed to wild stocks, though the evidence is mixed and the consequence not likely as severe as an exotic disease. The potentially affected wild populations have more experience with and resistance to indigenous diseases.

With respect to colonization, competition, and genetic effects due to escapes of farmed fish, the TAT has concluded there is some possibility of escaped farmed Atlantic salmon establishing themselves by spawning in the wild, particularly if the number of escapees grows over time with increased farmed production. It is further possible that the Atlantics could displace some wild stocks, if the wild stocks were stressed or for other reasons not as competitive as the Atlantics, though this could in most cases likely be mitigated through targeted harvesting of the Atlantics. There is a greater possibility of farmed Pacific salmon (chinook, coho) displacing weaker, wild stocks.

The TAT has concluded that there is little possibility of escaped Atlantics breeding with wild Pacific stocks, but escaped farmed coho and chinook could, adversely affecting the genetic diversity of wild coho and chinook stocks, with possible reproductive or other long term effects.

However, whatever displacement of, or genetic impacts on, wild coho and chinook stock that may occur as a result of salmon farming, they are likely to be minor compared to that already caused by the salmon enhancement program (SEP).

If any of these biophysical effects were to occur, particularly effects with potentially widespread consequence such as exotic disease, the economic impacts could be very large. Commercial and sports fishing and aboriginal subsistence economies would all be affected. There would be costs of foregoing catch, to allow wild stocks to rebuild, and/or costs of enhancement to rebuild runs. To date, however, no such effects have been identified in British Columbia from current salmon farming practices, and the probability of significant effects in the future is very low. The most likely impact is continued escape and harvest of farmed fish and possibly even some colonization in the wild, but this is not likely to have any significant economic consequences in terms of reduced

quantity or value of catches. It is more of a social and possible ecological concern of those who are offended by the inadvertent introduction of Atlantics in Pacific River systems.

Other Fishery Resources and Marine Mammals

Impacts of salmon farming on other fisheries resources are more localized than the potential impacts on salmon, and more dependent on the specific characteristics of each individual salmon farming site.

There are local concerns about the impact of farms on the productivity and quality of nearby shellfish beds. There is little evidence or understanding to date of why nearby shellfish beds should be less productive, though increased turbidity and tidal effects may be responsible. This may also be responsible for the fouling of shellfish beds reported by some aboriginal communities. In addition to the impacts on nearby shellfish beds, there are likely to be losses of fish resources underneath farms due to the build-up of sediments (specifically, geoducks and sea urchins). There are, on the other hand, shellfish cultivation opportunities afforded by salmon farms which could be considered, but that would require regulatory change.

Uptake by shellfish and other resident fish of antibiotics and metals (copper, zinc) is of concern, particularly to aboriginal communities who are so dependent on shellfish and other marine resources for their diet. The uptake is of greatest concern for shellfish because of their biomagnification of contaminants. Antibiotic uptake renders shellfish near farms unsafe for human consumption for up to 30 days. It may also be responsible for the tainting of shellfish reported by aboriginal communities. Lack of public notice about the timing of antibiotic treatments exacerbates the effects. Local residents are left uncertain about the safety of shellfish consumption throughout the year.

There are concerns about the effect of night lighting on herring and other fisheries resource attracted to the farms. The TAT has concluded, however, that there is no technical evidence of night lighting causing significant impacts on resident or migrating stocks. There is some evidence of localized effects on larval fish.

Finally, there is some interference with prawn longline and other fishing due to the farms. Fishers can be prevented from accessing traditional fishing areas or mooring in attractive locations. Also, debris from old farms can foul nets and eliminate attractive anchorages. This can occur particularly when farms go out of business, without proper clean up, as has happened in a number of instances in the Sechelt area.

These impacts are clearly of concern and of great significance to the individuals and communities affected. For First Nation communities in particular, the impacts are of great significance because of their dependence on fishery resources for their diet and culture and because of pollution, increased commercial harvesting and other factors already depleting their resource base.

In terms of the extent of the impacts of salmon farming itself, however, it is important to recognize that the percentage of the fishery resources that are affected is quite small. GIS resource mapping in the Broughton study area, for example, suggest that fish farms potentially affect less then 5% of the available resources (see Table 23).

Table 23—Broughton Area GIS Mapping Results

Preliminary Assessment	Potentially Affected Area	Resource Total Based on
Clams	6 farms within 125 metres of a clam bed	151 clam areas
Crab	4 farms within crab areas	6,850 ha. of crab areas
Herring	1 farm within a herring area	284 lineal kms
Prawns	10 farms within prawn areas	48,600 ha. of prawn area

Source: C. Berris Associates.

The GIS results must be viewed as rough, because local resources are not always known and the quality of the sites are not fully differentiated. Also, impacts may be more extensive than assumed in the analysis (e.g., beyond

125 m. for clam areas). Further, the percentage of resources affected in the vicinity of particular communities can be much higher.

Nonetheless, from a broader regional and certainly coast-wide perspective, it is clear that the percentage of the total resources that are affected is low and, in areas where these resources have generally been underutilized (e.g. the Broughton), the main impact has probably been to divert harvesting activity to other areas. This can impose some costs and can be problematic for some communities (e.g., in First Nation communities where alternative sites may be the traditional harvesting area for other families or bands). However, there does not appear to be evidence to date of any significant reduction in harvest levels, income or employment from these biophysical effects of salmon farming. This could, of course, change as pressures on the resource increase and diversion to other areas is no longer possible, or if the extent of the biophysical effects were to increase because of an increased number and/or inappropriate siting of farms.

The variety of measures such as acoustic deterrent devices (ADDs) and guns used by salmon farms to prevent marine mammals from preying on salmon and damaging nets has raised significant concerns about the impacts on these animals. There is evidence to suggest that ADDs can alter normal migration routes of whales and porpoises and may also cause hearing damage to marine mammals. However, while ADDs may affect marine mammal migration patterns, there is no evidence to date that they have affected the size of marine mammal populations. Even the shooting of seals and sea lions has not significantly affected total populations which are estimated to be growing rapidly on the west coast. With respect to economic impacts, the main impacts of fish farming on marine mammals to date have been possible displacement of or interference with wildlife viewing opportunities in certain areas (see below). The killing of marine mammals could have more serious consequences in that it could harm British Columbia's "Super Natural" image and even provoke trade sanctions by animal rights groups.

Marine Recreation and Tourism Resources

Marine recreation and tourism activities include

(CRIS data) 3 farms affecting important recreation areas 21 important areas

**All mapping data based on LUCO's GIS data except for "Recreation Areas" which is from CRISSource: C. Berris Associates*

To better understand the nature and significance of the impacts of fish farms on marine recreation and tourism, a survey of commercial operators in the Broughton Archipelago was undertaken in conjunction with the Ministry of Tourism, Business and Culture. There are 60 to 80 marine tourism operators, including lodges and resources, marine charters, air charters, kayak touring and marinas in the Broughton. For this review, 50 operators were contacted and 29 completed survey questionnaires. The 29 operators reported employing of 271 persons, mostly on a seasonal basis. The estimated full time equivalent person years of employment, including owner and operators, was 106. Some 31% of the workers live in the Broughton area. The operators reported having almost 30,000 clients in 1996, more than double the number five years ago. The growth in activity over the 1991 to 1996 period has averaged some 17% per year.

With respect to the effects of salmon farming, 15% of the operators stated that fish farms had only positive effects, 65% stated that fish farms had only negative effects and 20% stated that fish farms had both positive and negative effects. Positive impacts that were cited include: points of interest, safe havens, and educational tour opportunities. Negative impacts that were cited included: visual detraction, adverse impacts on fish and wildlife, blocked access to tourism resources (e.g. anchorages), reduced wilderness experience, pollution, odor and noise. Because different marine tourism activities rely on different environmental attributes, the extent to which these positive or negative impacts affect tourism will vary. Activities dependent on a pristine and abundant wildlife, such as kayaking, scuba diving, and whale watching, particularly activities which also require access to sheltered bays anchorages, are most negatively affected. Activities such as power boating and sport fishing are much less negatively affected—and, in some cases, positively affected. These activities, in particular sports fishing, are by far the largest contributor to tourism-related economic activity. A concern cited by these operators was the loss of anchorages in sheltered bays. However, the operators did not see the growth in their activity being affected by salmon farms.

Overall, the operator survey indicates that commercial marine tourism activity as a whole, and related income and employment, has grown substantially despite any negative impacts of fish farms. Discussions with recreation representatives indicate that non-commercial recreation and tourism (e.g., boating and kayaking) have also grown rapidly in the Broughton. The main reason for this appears to be that operators and recreationists have been able to find other routes, anchorages and fishing areas within and outside the Broughton to minimize the impacts of farms, without altering their base of operations.

Some operators feel that the tourism component of their business has actually declined or that their businesses could have grown more rapidly without farms. Kayakers also prefer fewer or no farms, and believe that kayaking activity in areas such as the Broughton and Clayoquot Sound has been reduced by the presence of farms. However, even though marine recreation and tourism might have grown more rapidly in such areas without fish farms, it is likely that the impact up to now has been more to divert some activity to other regions. In other words, it is unlikely that overall provincial marine recreation and tourism activity has been affected.

The impacts on marine recreation and tourism could become more evident in certain regions by an increased number and inappropriate siting or operating practices of farms, or provincially if B.C.'s "super natural" reputation is affected. However, it is also important to recognize that growth potential in recreation and tourism use may ultimately be limited, even with no increase in the number of farms, as popular destinations such as the Broughton Archipelago and Clayoquot Sound become increasingly crowded.23 This would be particularly true if use levels began to disturb wildlife such as whales, which are a key attraction in both of these areas.

Upland Property

The noise, smell and visual effects of farms, as well as the debris that can wash ashore or which is associated with land-based buildings, can significantly affect the aesthetic and economic value of upland property use—particularly residential or recreational use.

Farms are supposed to be sited to avoid impacts on upland property, but there are instances where such impacts occur. Impacts are most significant where farms are located in small bays or inlets near residential areas or recreational properties, such as Sooke basin, Cypress Sound in Clayoquot Sound and previous farms on the Sunshine Coast. The Comox-Strathcona Regional District has also reportedly received a number of complaints from upland owners. Another example is the farm located at Carrie Bay near the Gilford Village Indian Reserve in the Broughton, not only with impacts as noted above, but adding "insult to injury" to First Nations who feel they bear a disproportionate share of the impacts of farms, without offsetting benefits.

No estimates are available on the diminution of property values due to salmon farms. The overall total would likely be small because of the remoteness of the sites and the intent to avoid conflicting upland property use. However, as with other site-specific impacts, while not significant on a provincial scale, they are very significant to the individuals or communities affected.

Other Resource Impacts

Other resource and marine activity that can be affected by salmon farms include archaeological resources and navigation and safety. Impacts on archaeological resources, particularly due to onshore buildings and activity are of concern, but are not well documented because of the absence of site surveys prior to licensing. Access and quality of viewing can be negatively affected.

Navigation and safety can be affected both negatively and positively. Examples have been provided in the Local Information Report and to the Review Committee about farms extending beyond their boundaries and the use of night lights posing hazards to navigation. Others have indicated that farms can provide safe havens for boaters. Generally, however, all of these impacts are limited because of the remote location of the sites.

IV. SOCIAL IMPACTS

For this review, the social impacts of salmon farming are assessed in terms of the nature, extent and significance of its effects on different communities. First, the effects of salmon farming on the three major communities within the Broughton Archipelago study area (Port McNeill, Alert Bay and Sointula) are discussed. This is followed by a discussion of the specific effects of salmon farming on First Nations communities.

A. IMPACTS ON STUDY AREA COMMUNITIES

Data sources for the assessment of the social impacts on the major communities within the study area include:

- publicly available information on the socio-economic profile of the Broughton Archipelago communities;
- a survey by MSA of the two major salmon farming companies and the one processing plant operating in the study area, to collect data on employment, place of residence and key suppliers; and
- interviews by MSA with approximately 10 industry representatives, suppliers and community officials to collect information on the impacts of the aquaculture sector on the area and on local residents and businesses.

Socio-Economic Profile

In Table 25, 1991 census and 1996 population estimates are shown for the study area and other Mount Waddington district communities. The population within the study area communities is quite small—estimated at 4,825 in 1996. However, it is estimated to have grown by almost 10% over the past five years.

Table 25—Study Area amd Mount Waddington District Population

	1991	1996*	% INCREASE
Alert Bay	647	697	7.7
Port McNeill	2,717	3,014	10.9
Rural Broughton Area**	1,039	1,114	7.2
Subtotal	**4,403**	**4,825**	**9.6**
Port Hardy	5,230	5,470	4.6
Port Alice	1,411	1,626	15.2
First Nations reserves+	1,750	1,900	8.6
Rural—other++	1,506	1,620	7.6
Mount Waddington District	**14,300**	**15,441**	**7.8**

**Estimate*
***Includes Sub-Division A which covers the Mainland areas, and a group of islands in the Queen Charlotte Strait (the largest of which is Malcolm Island, where the village of Sointula is located).*
+Some of the First Nations reserves are based in the Broughton Archipelago area.
++Includes Sub-Division B of the Mount Waddington District which covers the Vancouver Island portion of the District, and includes the small communities of Woss Lake, Holberg, Hyde Creek, and Coal Harbour.
Source: BC Stats, Ministry of Finance and Corporate Relations.

Port McNeill, Alert Bay and Sointula are the three largest communities within the Broughton Archipelago—they are briefly profiled below.

Port McNeill: The town of Port McNeill began as a Pioneer Timber's Logging Camp which was floated from Malcolm Island in 1937. To this day, the forest industry continues to dominate the economy of Port McNeill. The major forest products operations in Port McNeill and smaller surrounding communities include the logging divisions of:

- MacMillan Bloedel Ltd.;
- Canadian Forest Products Ltd. (Canfor);
- Western Forest Products (WFP); and
- TimberWest Forest Limited.

Other employers in the forest sector include half a dozen small sawmills and wood products processing plants; log harvesting and log hauling contractors; tree planting and silviculture contractors; and forestry consulting firms.

Alert Bay: Alert Bay is situated on Cormorant Island approximately 10 Km offshore from Port McNeill. The village of Alert Bay has had a long history of settlement, starting with the development of a salmon saltery in 1870. Alert Bay developed around the fishing industry, the administration of education for First Nations and the coastal transportation and communication

industry. Alert Bay's role as a coastal administration centre diminished with the completion of the Island Highway to Port Hardy in the early 1970s. Commercial fishing is the dominant economic activity in the village of Alert Bay. The tourism sector has been gaining in importance.

Sointula: The community of Sointula is located on the south shore of Malcolm Island. It is accessible by ferry to Port McNeill and Alert Bay. The commercial fishing sector dominates the local economy of Malcolm Island.

The following table summarizes employment by sector for the communities of Port McNeill, Alert Bay and the rural areas in the Broughton Archipelago, which includes Sointula. The employment statistics are for 1991 and the aquaculture sector is considered part of fishing and trapping.

Table 26—Study area community employment by sector, 1991

	Mount Archipelago Alert Bay	Broughton Port McNeill	Waddington —Sub A	Total— Number	%
Forestry	635	84	719	33.3	
Fishing and Trapping	41	43	137	220	10.2
Agriculture		11		11	.5
Tourism	46	170	27	243	11.3
Public Sector	152	237	52	441	20.4
Other Basic*	83	28	23	134	6.2
Non-Basic**	48	287	57	392	18.1
Total	370	1,410	380	2,160	100.0

**The Ministry of Finance and Corporate Relations defines basic sector employment as being created by the components of the economy that result in the flow of outside dollars into the area. This may originate from industrial sources such as the aquaculture sector or non-industrial sources such as investment income, pensions, and government transfer payments. Other Basic includes the transportation, construction and mining sectors.*

***Non-Basic includes services not included above (e.g. retail, insurance, finance, etc.).*

Source: BC Stats.

The employment data are somewhat dated (based on the 1991 census) and do not reflect the declines in both forestry or fishing that have taken place in recent years. Nevertheless, they do clearly indicate the primary importance of the forest sector, particularly in Port McNeill. They also clearly show the importance of fishing in Alert Bay and Sointula, and the very significant role of tourism throughout the region. Tourism is in fact, the second largest private sector source of employment.

Marine recreation and tourism activity has grown substantially in recent years (reportedly more quickly than other components of the tourism sector), evidenced by the increasing number of commercial whale watching, kayaking and sport fishing lodges in the area. The recent designation of part of the Broughton as a protected area and increasingly crowded conditions in other popular recreation areas such as Desolation Sound, have reinforced these growth trends. Telegraph Cove, and to a lesser extent Port McNeill and Port Hardy are the major supply centres and basis for marine recreation in the Broughton. A 60 room accommodation complex is under construction and a whale watching research centre and golf course are under consideration in Telegraph Cove.

Salmon Farming Operations in the Study Area

Salmon farming companies operating in the Broughton Archipelago area include:

- **Stolt Sea Farms**—Stolt Sea Farms operates 12 grow-out sites and two hatcheries in the Broughton Archipelago. Other operations outside the case study area include a hatchery in Sayward and two operating sites in Quatsino Sound near Coal Harbour, closer to Port Hardy. The administration office is in Campbell River.
- **B.C. Packers**—BC Packers operates 6 grow-out sites in the Broughton Archipelago. BC Packers' administration office is also in Campbell River. Farmed salmon from the Broughton Archipelago sites is processed at the Brown's Bay Packing plant in Campbell River.
- **Englewood Packing Company Limited**—Englewood Packing is owned by Great Northern Packing Ltd. of North Vancouver with Stolt Sea Farms Inc. Brown's Bay Packing from Campbell River had been processing the fish produced at Stolt Sea Farms until Englewood Packing opened in late 1996. Englewood Packing employs approximately 40 people and it hopes to increase that to 100 in the spring of 1997, when it will start steak filleting and skinning. The plant will be able to process between 7,000 and 9,000 metric tonnes per year.

These companies employ 207 people in the Broughton Archipelago area operations. As shown in Table 27, an estimated 21% (44) of these workers reside in the Broughton Archipelago study area communities. The balance live in Port Hardy, Campbell River and the Comox/Courtenay area.

Table 27—Employment in the Aquaculture Sector in the Broughton Archipelago by Place of Residence of Employees

	Total	% Residing in the Broughton Archipelago*	Place of Resident of those not Residing in the Broughton Area
Operating Labour	121	11%	Port Hardy, Campbell River & Comox/Courtenay
Hatchery workers	22	11%	Port Hardy, Campbell River & Comox/Courtenay
Processing Labour	39	59%	Port Hardy
Mechanics	4	25%	Campbell River & other
Transportation**	2	100%	
Administration***	19	10%	Campbell River
Total	207	21%	Port Hardy, Campbell River & Comox/Courtenay

**Includes Port McNeill, Sointula, Alert Bay and other smaller communities in the Broughton area.*

****Some of the boat crews and skippers are included in the operating labour.**

****These administration jobs include only those that depend on the activities of the Broughton Archipelago. Two of the administrative positions are in Port McNeill, the balance are in Campbell River.*

Source: Based on a 1996 survey by the MSA Consultants of Stolt Sea Farms, B.C. Packers and Englewood Packing.

The majority of the local employment is in processing and is due to the opening of the Englewood Packing Plant. The plant attracted a lot of local interest. Mr. Dave Pashley, the plant manager, indicated that more than 100 local people applied for jobs when the plant opened.24 Approximately three quarters of the individuals now working at the plant were already established in the North Island area. Those coming from outside the area include:

- Mr. Pashley moved to the North Island from Prince Rupert where he worked in the commercial fishing industry for 23 years at the B.C. Packers cannery;
- 7 workers transferred from Campbell River;
- 1 individual relocated from Nanaimo; and
- 1 individual relocated from the Lower Mainland.

There is a high proportion of women working in the salmon farming industry, particularly in processing. In both Brown's Bay and Englewood Packing, women account for two-thirds of the labour force. One company representative indicated that at the grow-out sites and hatcheries, approximately half of the managers are women. Another indicated that women accounted for approximately 30% of the staff and operating labour.

The survey data show that there are 8 individuals of Aboriginal descent working at the farms in the Broughton Archipelago and the processing plant in Port McNeill. This represents approximately 4% of the total salmon farming labour force in the Broughton Archipelago.

Local Suppliers

There are no major dedicated aquaculture industry suppliers based in the Broughton Archipelago (except for Englewood Packing, the processing plant in Port McNeill). The farms in the Broughton Archipelago and Englewood Packing purchase items such as nets, cages, boats, boat engines, containers, boxes, rope and transport services from Campbell River and other B.C. locations.

The major businesses in Port McNeill and Alert Bay that benefit from the salmon farming sector also supply other industries such as the commercial fishing sector as well as the resident population in the area. The following items are generally purchased from suppliers in Port McNeill:

- food and other supplies for providing room and board services to most of the salmon farm workers (the major supplier is IGA);
- marine and other supplies such as rubber boots, rubber gloves, etc. (one of the major retail store is Shop Rite); and
- conventional construction services such as electrical services, concrete, plywood supplies, etc. (e.g. Norvan Construction, K&K Electric and Windsor Plywood.)

Suppliers identified in Alert Bay include:

- Alert Bay Petroleum Service Ltd.;
- Alert Bay Pile Driving Co. Ltd.—towing and tug boat services; and
- Canadian Fabricators—boat repair services.

One individual in the area commented that with two large salmon farming companies having their regional offices in Campbell River, fewer businesses from Alert Bay and Port McNeill are supplying the industry. That same individual indicated that his company previously provided services to one of the local farms when it was locally managed. Englewood Packing, the new processing plant in Port McNeill is viewed by community representatives as potentially opening opportunities for local businesses to supply the industry. The construction of the plant itself had a significant impact on local business.

Relative Importance of the Salmon Farming Sector

Based on the foregoing, it would appear that salmon farming has directly generated some 44 jobs in the Broughton area; the indirect (supplier) impacts are relatively small. These 44 jobs represent approximately 2% of total employment in the area, as compared to 33% for the forest sector, 11% for tourism and 10% for fishing and trapping.

The local impact is concentrated almost entirely in Port McNeill and is relatively small, much smaller than the impacts on larger centres outside the study area such as Port Hardy or Campbell River. However, the jobs are very significant to individuals who got them and have helped, because of predominately local hiring, to offset declines in other sectors. Further, there is some growth potential, particularly with the new processing plant.

No significant negative impacts of salmon farms have been identified to date on commercial fishing or marine tourism. Impacts on fishing are due to other factors and any impacts of salmon farming on tourism have not dampened its rate of growth. Nevertheless, these are very important sectors to the communities in the area, and the communities would be significantly affected by any negative effects. The risk or uncertainty of this no doubt is of concern to many residents in the area, particularly residents in Sointula and Alert Bay who do not benefit from salmon farming, and who depend so heavily on commercial fishing.

B. IMPACTS ON ABORIGINAL COMMUNITIES

Socio-Economic Profile25

First Nations' population in northern Vancouver Island is estimated at approximately 2,000 living on-reserve. Another 2,000 Band members live off-reserve in communities elsewhere on Vancouver Island (e.g., Campbell River) and the mainland (e.g. Vancouver). There are eleven First Nations whose territories lie largely or exclusively within northern Vancouver Island area, including six Bands with the Kwakiutl District Council (KDC) and five Bands with the Musgamagw-Tsawataineuk Tribal Council.

First Nations' population in the Broughton is roughly 1,200, comprising about one-quarter of the total population in the area. Most of the First Nations with populated reserves in the Broughton are affiliated with the Musgamagw-Tsawataineuk Tribal Council: the Namgis (by far the largest Band located near Alert Bay on Cormorant Island), Tlowitsis-Mumtagila (Alert Bay); Kwicksutaineuk (Gilford Island), and Tsawawataineuk (Kingcome Inlet). The Tanakteuk in Alert Bay is the only Band under the Kwakiutl District Council with members living on reserve in the Broughton, although several of the other Bands under the KDC have reserves and traditional villages in the area.

First Nations population in the area has been increasing steadily, in absolute terms and as a proportion of total population, over the past decade due to natural increases and Band members returning from urban areas. These trends are expected to continue.

Commercial fisheries activities constitute the most important source of employment for First Nations people in the Broughton including commercial fishing (almost 50 vessels employing up to 150 in Alert Bay alone), fish processing and shellfish harvesting. The fisheries resources of the Broughton are also central to the diet, culture and spiritual well-being of First Nations people. Other main sources of livelihood include: public administration (including Band Council, Fisheries Commission, education, health), logging and forestry silviculture, fisheries enhancement and training projects and trapping.

Although quantitative estimates are not readily available, the unemployment rate in First Nations communities is known to be several times higher than for the population as a whole. The decline in the fisheries due to stock depletion and habitat destruction, the loss of boats, and declines in forestry primarily due to unsustainable timber harvesting will exacerbate the unemployment problem in First Nations communities. Current economic development initiatives are in forestry (e.g., woodlot, Timber Sale Licenses, silviculture/watershed restoration and training proposals), fisheries (e.g., enhancement projects) and tourism (e.g., sport fishing resort).

Impacts of Salmon Farming on Resource Use

First Nations depend heavily on marine resources both for commercial activity (in particular, commercial fishing) and for their subsistence economy. In a study for the Kwakiutl Territorial Fisheries Commission, Weinstein and Morrell (1994) estimated the subsistence catch of the Comox Quatsino Bands between September 1992 and August 1993 of about 12,000 pieces of salmon, 600-700 pieces of groundfish, 4,200 pounds of herring and herring-roe, 14,400 pounds of shellfish and some consumption of marine mammals. The subsistence activity is not simply a source of food. "...subsistence is an integrative activity. It connects individual activity with family and group welfare, and these in turn with direct experience of the state of resource animal populations and environmental quality. Resource harvesting is the connector between environment, communities, human history and individual and family life."26 All Kwakiutl communities have high degrees of kin linkages and joint work group structures that are involved in food harvesting and distribution (e.g., through potlatches).

Clams are a central item in the Kwakiutl diet and they are normally served at potlatches and other ceremonial occasions. Fort Rupert and Gilford Island are the only communities near enough to clam beds to allow harvesting without boats. Clams are generally less accessible than historically. Clam beds near Comox, Cape Mudge, Campbell River, Fort Rupert, Quatsino and Port Hardy have all been polluted by sewage outfalls or industrial effluent (Island Copper Mine, Elk Falls pulp mill). Although needs in more remote communities are generally being met, those without access to boats are having more difficulty.

Salmon farms are reported by First Nations to have impacted clam resources, exacerbating pollution and other threats to these resources. While clam consumption is reportedly still increasing, the salmon farms are forcing some communities to seek out alternative sources, and are increasing the difficulty and cost of access to this important resource.

Other resources have not been affected to the same extent, but the risks are of concern to First Nation communities. They are added threats to their traditional way of life and principal source of employment.

Participation in the Industry

For the most part, First Nation participation in the employment or business opportunities afforded by salmon farming has been very limited. An estimated 8 persons from First Nations are employed in Broughton Area operations (some 4% of the total number of jobs). An estimated 50 to 60 persons from First Nations are employed in salmon farming related activity throughout the province (some 5% of the total number of jobs).27 Most of these jobs are in processing or hatchery-related work.

There is currently no First Nations' business participation in any active farms, though one joint venture hatchery operation has been reported. Other First Nation investments in salmon farming have failed (e.g., the Sunshine Coast and Kitimat areas) or promises of joint ventures have been withdrawn (e.g., Beaver Cove). Generally, the capital-intensive nature of salmon farming and extensive vertical integration in the industry has not been conducive to successful First Nations involvement.

Participation in the Regulatory Review Process

Salmon farms are often located in areas where First Nations live or which are important in terms of traditional use or spiritual significance. The impacts of salmon farms are also most likely to affect First Nations communities disproportionately to others because of their dependence on marine resources. Nonetheless, First Nations have not had, in their view, effective or sufficient involvement in the regulatory review process for farm siting.

Farms have been located in traditional areas over the objections of First Nations groups. Farms have been approved or have operated in apparent conflict with guidelines.

The Kwakiutl Territorial Fisheries Commission (KTFC) has documented a number of resource conflicts and regulatory compliance problems with farms in their territories, including 3 sites operating too close to shellfish beds, 2 sites near salmon rearing areas, 2 farms off lease areas, inadequate cleanup of debris (e.g., nets, feed bags, rope, chain, etc.) at 6 sites. Their submission states that there are at least 10 farms located directly in CRIS "red zones" (i.e., areas identified as no opportunity for farming by stakeholders because of conflicts with salmon migration routes, shellfish beds, stream mouths, recreation sites, etc.)1 First Nations also argue that their participation in referral/regulatory process for amendments to farm permits (e.g., for expansion, different species, drugs and chemicals used to promote growth and prevent disease) is even less adequate.

Overall, the impact of salmon farming on First Nations communities has been negative, with some adverse impacts on resources, insufficient regulatory control and insufficient offsetting employment benefit.

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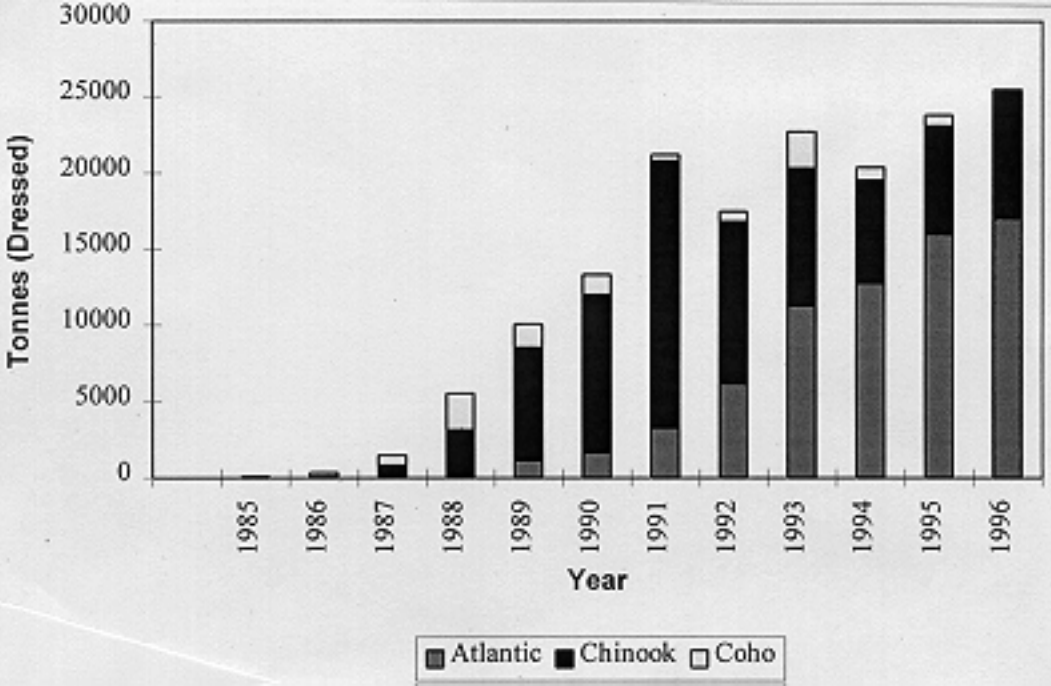
30000
25000
20000
15000
10000
5000
0
Tonnes (Dressed)
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
Year
Atlantic
Chinook
Coho

PART B—TABLE OF CONTENTS

SUMMARY

This paper presents an overview of the management and regulatory framework for salmon aquaculture in British Columbia. It provides an outline of the main legislation, regulations, policies and programs currently in place to assess applications and regulate ongoing operations related to salmon aquaculture.

The paper has been prepared for the Salmon Aquaculture Review being conducted by the provincial Environmental Assessment Office and largely focuses on the five key issues that are the subject of that review: fish farm siting, escaped farm fish, fish health, waste discharge, and interactions with marine mammals and other species.

Salmon aquaculture operates within a regulatory framework involving requirements set by federal, provincial and local governments. In 1988, a federal-provincial Memorandum of Agreement divided the responsibility for regulating aquaculture between the federal government and the province, assigning many of the responsibilities for ongoing administration to the province. Since that time, the province has assumed the role of licensing salmon aquaculture operations in British Columbia.

In relation to the siting of salmon farms, the provincial *Land Act* provides the framework for issuing tenure over Crown land, where most salmon farms in B.C. are located. The Ministry of Environment, Lands and Parks administers this process. A referral process is used to solicit comments on the application for tenure from a variety of agencies and parties both in and out of government, including First Nations.

In some cases, local governments have official community plans and zoning bylaws relevant to the siting of salmon farms.

An Aquaculture Development Plan must be submitted and approved by the Ministry of Agriculture, Fisheries and Food prior to a salmon farm beginning to operate.

The provincial *Fisheries Act* provides that every salmon farm must have an aquaculture licence which is subject to a number of general and site specific terms and conditions. In addition, the provincial Aquaculture Regulation contains a number of operating requirements applicable to all salmon farms.

The issues of escaped farmed fish, fish health, waste discharge and interactions with marine mammals and other species are regulated by a mix of instruments, some federal and some provincial.

The regulatory and management framework is subject to a variety of statutes, regulations, policies and guidelines. For the purposes of this paper, these terms are used as follows:

- statutes are laws or Acts which express the will of a legislature or Parliament and may be enforced by a variety of legal means;
- regulations are rules, orders or other instruments having the force of law which are issued or made in the execution of a power conferred under the authority of an Act or under the authority of Cabinet;

- policies are government commitments to follow particular actions or courses of action in pursuit of approved objectives and generally do not have the force of law;
- guidelines are requirements that generally do not have the force of statute or regulation and, therefore, usually cannot be enforced through legal means—they are often used where decision makers are expected to exercise discretion in the application of the provisions of the guidelines.

The Salmon Aquaculture Review is intended to assess whether the management and regulatory practices are being implemented effectively and whether they are adequate to address any concerns arising out of the key issue areas or whether new responses are needed. The effectiveness of the management and regulatory framework and its application will be assessed following completion of the reports of the Technical Advisory Team on the key issues that are the subject of the Review.

Following the Review, the Environmental Assessment Office will make recommendations to the Ministers of Environment, Lands and Parks and Agriculture, Fisheries and Food regarding the procedures used to manage and regulate salmon farms and will give the Ministers policy advice.

The final section of this paper lists concerns about the regulatory and management framework that have been identified while preparing this overview and by members of the Salmon Aquaculture Review Committee during the Review process. These and other issues being tracked by the Environmental Assessment Office may be assessed and considered in the development of options to address possible changes to the management and regulatory framework for salmon aquaculture in B.C.

I. INTRODUCTION

This paper presents an overview of the management and regulatory framework for salmon aquaculture in British Columbia. Its purpose is to provide a general outline of the main legislation, regulations, policies and programs governing the salmon aquaculture industry in the province and to discuss their application.

It has been prepared for the Salmon Aquaculture Review being conducted by the provincial Environmental Assessment Office. The Review is examining the procedures, practices and policies government uses to assess applications and regulate ongoing operations related to salmon aquaculture, with a particular focus on five key issues: fish farm siting, escaped farm fish, fish health, waste discharge, and interactions with marine mammals and other species.

The Review is intended to assess whether the management and regulatory practices are being implemented effectively and whether they are adequate to address any concerns arising out of the key issue areas or whether new responses are needed. The effectiveness of the management and regulatory framework and its application will be assessed following completion of the reports of the Technical Advisory Team on the key issues that are the subject of the Review.

The final section of this paper lists concerns about the regulatory and management framework that have been identified while preparing this overview and by members of the Salmon Aquaculture Review Committee during the Review process.

Throughout the paper, aspects of the regulatory and management framework that are not closely linked to the five key issues or have not been identified as areas of significant concern may be described in less detail than those aspects of the framework that have been identified as areas of concern.

Following the Review, the Environmental Assessment Office will make recommendations to the Ministers of Environment, Lands and Parks and Agriculture, Fisheries and Food regarding the procedures used to manage and regulate salmon farms and will give the Ministers policy advice.

This paper has been prepared primarily as a tool for use during the Review to provide a description of the existing management and regulatory framework and to explain the current application of the relevant statutes, regulations, policies and guidelines. For the purposes of this paper, these terms are used as follows:

- statutes are laws or Acts which express the will of a legislature or Parliament and may be enforced by a variety of legal means;
- regulations are rules, orders or other instruments having the force of law which are issued or made in the execution of a power conferred under the authority of an Act or under the authority of Cabinet;
- policies are government commitments to follow particular actions or courses of action in pursuit of approved objectives and generally do not have the force of law;

- guidelines are requirements that generally do not have the force of statute or regulation and, therefore, usually cannot be enforced through legal means—they are often used where decision makers are expected to exercise discretion in the application of the provisions of the guidelines.[1]

While this paper may assist in identifying areas where changes to the management and regulatory framework would be beneficial, it does not present options for specific changes to that framework. Options to address possible changes to the management and regulatory framework will be developed after the Salmon Aquaculture Review Committee has received and reviewed the reports of the Technical Advisory Team on the key issues that are the subject of the Review.

Aquaculture has been defined as the "rearing of aquatic organisms under controlled and semi-controlled conditions,"[2] a definition that includes plants and animals. As an industry, aquaculture straddles the line between fishing and farming,[3] which places it in a complex jurisdictional setting. In B.C., the salmon aquaculture industry perceives its activities to be closer to farming than fishing and the province often characterizes salmon aquaculture as a farming activity. However, there has been no judicial consideration of this point.

II. JURISDICTION

A. CONSTITUTIONAL DIVISION OF POWERS

In Canada, both the federal Parliament and provincial Legislatures may enact valid legislation according to the powers distributed between them in the Constitution. The *Constitution Act, 1867* (formerly the *British North America Act, 1867*) is the primary constitutional document that divides and allocates legislative power between the two orders of government which make up our federal system.

When the division of constitutional powers was established in 1867, it did not specifically list aquaculture and assign it to a particular order of government. However, the *Constitution Act, 1867* is framed to allow aspects of the constitutional field to be regulated by both the British Columbia Legislature and the Parliament of Canada, each acting within its exclusive constitutional jurisdiction.[4]

For example, the practice of aquaculture involves the constitutional jurisdiction of the province to make laws in relation to

- the management and sale of public lands belonging to the province [section 92(5)],• licences for the raising of a revenue for provincial purposes [section 92(9)],• local works and undertakings [section 92(10)],•property and civil rights in the province [section 92(13)], and• generally all matters of a merely local and private nature in the province [section 92(16)].

Judicial interpretation of these constitutional powers, the most far-reaching being the provincial authority over property and civil rights, makes it clear that the province has the power to regulate many aspects of aquaculture. The scope of permissible provincial regulation includes regulating in areas such as;

- the management and use of Crown land;• the licensing of aquaculture operations;• the setting of standards for the business of aquaculture and those who conduct it;• local marketing and consumer protection;• waste management and environmental assessment applicable to aquaculture operations; and,• labour relations and employment standards on aquaculture operations.

On the other hand, the Parliament of Canada also enjoys constitutional power which may touch on the subject of aquaculture and which may overlap with provincial powers. Relevant federal powers include the power to legislate in relation to

- federal public property [section 91(1A)],• sea coast and inland fisheries [section 91(12)],• navigation and shipping [section 91(10)],• Indians and land reserved for Indians [section 91(24)], and• the national concern branch of the peace, order and good government power.

These powers have been interpreted to allow the federal Parliament to pass laws to

- preserve and protect the environment of wild fish,• control marine traffic and pollution in Canadian waters, and• require environmental assessment of projects that have any effect on matters within federal legislative jurisdiction.

Even though these are areas of exclusive federal and provincial legislative power, there are some areas of similarity and overlap particularly in relation to protecting wild fish habitat. Our constitutional law system accommodates such overlap and provides that federal and provincial laws that have been enacted for valid constitutional purposes may coexist as long as they are compatible.[5] In fact, section 95 of the *Constitution Act, 1867* expressly confers concurrent federal and provincial powers over agriculture and confirms the paramountcy of federal laws. It is only if two laws are so incompatible that they are operationally inconsistent that the courts will declare the federal law to be paramount. Federal paramountcy means that as long as the relevant federal law is active the conflicting provincial law is inoperative.

Apart from its constitutional power to enact laws, each order of government also has significant practical power arising from its executive power over Crown property and from its spending power. A government's executive power to control its own public property is very similar to the power any landowner has over his or her property. It allows the provincial or federal Crown, subject to legislation or the Constitution, to grant leases or licences in relation to its Crown land and to insist in those instruments on any terms and conditions that a private proprietor could insist upon. The second significant area of power is known as the spending power, under which governments may control behaviour in area conditional basis to other governments or private persons. Those conditions may, of course, have significant implications for the behaviour of citizens, businesses or industries who wish to accept government funds.

It is important not to confuse the power to enact legislation with the actual exercise of the power. For example, despite the constitutional power to make laws regulating a particular subject matter, a particular order of government may choose for policy reasons not to enact laws, may choose to regulate in only a limited way, or may choose to regulate in a comprehensive fashion.

B. FEDERAL PROVINCIAL MEMORANDUM OF UNDERSTANDING

In 1988, the federal government and the province of British Columbia signed a Memorandum of Understanding dealing with the development of aquaculture. The Memorandum of Understanding sets out the agreement between the two levels of government dividing the responsibilities for the administration and regulation of the aquaculture industry. The Memorandum of Understanding addresses a number of important areas, including research and development, education and training, provincial licensing and regulation, federal regulation, co-ordination between the parties,

dispute resolution, compliance and inspection, feed, egg supply, therapeutants and vaccines, and recording statistics. It also provides for the establishment of a Management Committee to oversee the management and implementation of the Memorandum of Understanding.

Under the Memorandum of Understanding, the province agrees to carry out a number of functions in relation to the administration, licensing and regulation of aquaculture. Of particular importance, the agreement provides that the province may issue licences to carry out aquaculture operations in British Columbia. Therefore, since the signing of the Memorandum of Understanding the federal government no longer issues licences to operate salmon farms in B.C.

In addition, the agreement provides that in establishing regulations and policies the province may address various issues including the development and management of the industry,

- the size and location of aquaculture facilities,• the use and enforcement of site development plans,• reporting requirements,• protection of confidentiality regarding information from licence holders and applicants, and• standards relative to the design, construction materials and layout of aquaculture facilities.

The Memorandum of Understanding further provides that the federal government has regulatory authority for issues including the health of fish in aquaculture facilities, the conservation and protection of wildstocks and fish habitat with respect to aquaculture, and the protection of navigable waters.[6]

The Memorandum of Understanding states that the Department of Fisheries and Oceans will act as the lead federal agency for aquaculture in British Columbia.[7] It also states that the provincial Ministry of Agriculture, Fisheries and Food will act as the lead provincial agency in dealing with the federal government.

C. THE FEDERAL AQUACULTURE DEVELOPMENT STRATEGY

The federal government has developed a Federal Aquaculture Development Strategy[8] outlining the federal policy framework in relation to the aquaculture industry. The Strategy deals with the cultivation of a number of species, including salmon. It describes the federal role in aquaculture development, dividing it into a number of components including the regulatory framework applicable to aquaculture. In relation to this regulatory framework, the Strategy states that the federal government will undertake a comprehensive review of all federal legislation and any accompanying regulations to identify and remove constraints to aquaculture development, where appropriate.[9]

The core implementation teams for the Federal Aquaculture Development Strategy are industry-government Aquaculture Implementation Committees with representation from industry associations, academia and relevant federal and provincial agencies and departments. The Committee in this region is considering whether amendments to the Memorandum of Understanding between the federal and provincial governments are needed.

D. PROVINCIAL AGREEMENT FOR AQUACULTURE DEVELOPMENT ON CROWN LANDS

As a practical matter, at the provincial level the principal regulatory bodies are the Ministry of Agriculture, Fisheries and Food and the Ministry of Environment, Lands and Parks.

In 1990, the provincial Ministry of Agriculture and Fisheries[10] and the Ministry of Crown Lands[11] signed a Memorandum of Agreement titled Aquaculture Development on Crown Lands. The purpose of the agreement is to define the respective roles of the Ministries regarding aquaculture development and to clarify and streamline administrative processes. It addresses a number of issues, including

- the coordination of information,
- the form of aquaculture development plans,
- procedures for processing applications,
- public competition for aquaculture sites,
- tenure and licence administration,
- inspections,
- consultation for policy and regulatory issues, and
- cooperation regarding planning.

The agreement provides that B.C. Lands[12] is responsible for cancelling tenure for non-compliance with the terms of a licence of occupation or lease and the Ministry of Agriculture, Fisheries and Food is responsible for cancelling licences for non-compliance with conditions related to aquaculture operations, where such actions are necessary. It further provides that both ministries will attempt to coordinate site inspections in connection with applications for or monitoring of tenures or licences.

III. FIRST NATIONS

A. BACKGROUND

The law in Canada in connection to aboriginal people has undergone significant changes in recent years and continues to evolve today. In light of this and given the importance of wild fish to First Nations in British Columbia, it is necessary to review some aspects of this area of law in order to determine if any possible impacts of salmon farming have the potential to affect aboriginal rights.

Under section 91(24) of the *Constitution Act, 1867*, the federal Parliament has the power to make laws in relation to "Indians, and lands reserved for the Indians". The federal government takes the view that this power allows it to legislate for "Indians"[13] in relation to matters which would otherwise be outside its jurisdiction, such as property and education.

With respect to provincial legislative competence, the general rule has been that valid provincial laws of general application apply to Indians and lands reserved for Indians. Section 88 of the *Indian Act*[14] incorporates by reference provincial laws of general application and makes such laws applicable to Indianness (the primary or core aspects of federal jurisdiction over Indians), subject to the terms of treaties and federal legislation. Section 88 provides:

> Subject to the terms of any treaty and any other Act of the Parliament of Canada, all laws of general application from time to time in force in any province are applicable to and in respect of Indians in the province, except to the extent that such laws are inconsistent with this Act or any order, rule, regulation or by-law made thereunder, and except to the extent that such laws make provision for any matter for which provision is made by or under this Act.

Section 88 applies to those laws which affect Indians as Indians or, to put it another way, which affect Indians differently than non-Indians.[15] Through the operation of section 88, provincial laws which would not otherwise be applicable to aboriginal persons because legislative power respecting Indians rests with the federal government are made applicable as incorporated federal laws. Ordinary provincial laws apply because of the legislative power of the province. Provincial laws affecting "Indianness" do not, however, apply to treaty rights.

Under section 88, a provincial law regulating inland fisheries or protection of fish habitat which would otherwise be valid because it was made under the province's authority over property and civil rights or management of public lands, for example, would be of no force to the extent that it was inconsistent with the provisions of the *Indian Act* or band bylaws made under it. It would also be of no force to the extent that it conflicted with the terms of any treaty.[16]

B. TREATY RIGHTS

Only a small area of the province is subject to treaties. Treaty No. 8 covers a portion of northeastern British Columbia and affirms hunting, fishing and trapping rights to those aboriginal people who are covered by the treaty.

The only other treaties in the Province are fourteen made on Vancouver Island, one in the vicinity of Nanaimo, two near Port Hardy and eleven in the area of Victoria and the Saanich Peninsula.[17] These treaties contain guarantees that the aboriginal peoples will be protected in their right to hunt and fish "as formerly."[18] The rights to hunt and fish extend beyond the tracts of land surrendered and include those lands where the tribes hunted and fished at the time the treaties were signed.[19] Development on the Crown foreshore which interferes with the fishing rights confirmed by the treaties will not be permitted.[20]

The aboriginal peoples who were a party to these treaties ceded their land to colonial authority partly in exchange for the right to hunt over "unoccupied" Crown land. Much of this Crown land is now occupied. By reason of section 88 of the *Indian Act*, provincial laws of general application that are inconsistent with the terms of any of these treaties are of no force to the extent of the inconsistency.

C. SECTION 35 OF THE CONSTITUTION ACT, 1982

Prior to 1982, aboriginal rights were vulnerable to provincial laws although treaty rights were not. Both aboriginal and treaty rights were vulnerable to federal legislation. Since 1982 and the coming into force of the *Constitution Act, 1982*, however, there has been a significant limitation imposed on the power of provinces and the federal Parliament to legislate in a way that affects aboriginal peoples. Section 35 provides in part:

> 35.(1) The existing aboriginal and treaty rights of the aboriginal peoples of Canada are hereby recognized and affirmed.
>
> (3) For greater certainty, in subsection (1) "treaty rights" includes rights that now exist by way of land claims agreements or may be so acquired.

Section 35 is not part of the *Charter of Rights and Freedoms* but is subject to section 52 of the *Constitution Act, 1982* which provides in part:

52.(1) The Constitution of Canada is the supreme law of Canada, and any law that is inconsistent with the provisions of the Constitution is, to the extent of the inconsistency, of no force or effect.

(3) Amendments to the Constitution of Canada shall be made only in accordance with the authority contained in the Constitution of Canada.

Although the meaning of "land claims agreements" has not yet been settled, section 35 will almost certainly extend constitutional protection to the rights created in the treaties which are currently being negotiated with First Nations in the province.

There are two significant aspects to the inclusion of aboriginal and treaty rights, including future treaty rights, in the Constitution. First, those rights are now entrenched and cannot be unilaterally amended or extinguished by either Canada or a province.

Second, any law that unjustifiably infringes an aboriginal or treaty right or, in the case of provincial laws, any law that infringes a treaty right is of no force or effect to the extent of the inconsistency. The Supreme Court of Canada considered section 35 in its 1990 decision, *R.* v. *Sparrow,* [21] in the context of an aboriginal right to fish for food and set out the following analysis for determining whether a right has been interfered with:

- Section 35 is to be construed in a purposive way and to be given a generous, liberal interpretation. The analysis is a two-step process.
- The first step is to ask if the legislation in question has the effect of interfering with an existing aboriginal right.
- If there is a prima facie interference, the second step of the analysis is to ask if the interference is justified. This involves an examination of the objective of the legislators to determine if that objective is sufficiently compelling and substantial to be valid. It also involves an inquiry as to whether the legislative objective upholds the honour of the Crown in its dealings with aboriginal people. Conservation of a resource and, therefore, preservation of the subject of the aboriginal right and the need to ensure public safety may justify interference with an aboriginal right.
- In relation to the second step, the Court emphasized the special trust relationship between the Crown and aboriginal peoples described in *R.* v. *Guerin* [22] and stated that the requirement of justification was the best way of holding the Crown to a high standard of honourable dealing.

D. ABORIGINAL RIGHTS

Aboriginal rights continue to exist in British Columbia today.[23] A number of very recent decisions of the Supreme Court of Canada[24] follow on the decision in Sparrow and provide an approach for identifying aboriginal rights. The following principles were enunciated by the Court:

- to be an aboriginal right an activity must be an element of a practice, custom or tradition integral to the distinctive culture of the aboriginal group claiming the right;
- to be integral, a practice, custom or tradition must be of central significance to the aboriginal society in question, one of the things which made the culture of the society distinctive;

- the practices, customs and traditions which constitute aboriginal rights are those which have continuity with the practices, customs and traditions that existed prior to contact with European society;
- the practice, custom or tradition must be independently significant to the aboriginal community claiming the right and cannot exist simply as an incident to another custom or tradition; and
- only aboriginal peoples can exercise aboriginal rights.

Any attempt at regulation by the federal or provincial government of an aboriginal right will be subject to scrutiny under the test in *Sparrow.* Where a First Nation is able to establish an aboriginal right to fish for food, for example, that right will have priority over all other rights to the fishery subject only to infringement that is justified under the analysis in *Sparrow* and *Gladstone,* most notably for purposes of conserving the resource, public safety or other compelling and substantial objectives.

Where an aboriginal right has no internal limitation (for example, to the amount of fish that can be consumed for food and ceremonial purposes only), the notion of priority, as articulated in *Sparrow,* would mean that an aboriginal right would become an exclusive right. In such circumstances, as, for example, where a First Nation is able to establish a right to fish to exchange fish for money or other goods or to sell fish commercially, conservation and public safety will not be the only compelling and substantial legislative objectives which justify infringing the right.[25] Where the aboriginal right has no internal limitation, the doctrine of priority requires that the government demonstrate that it has taken the existence of aboriginal rights into account in allocating the resource and has allocated the resource in a manner respectful of the fact that those rights have priority over the exploitation of the fishery by other users.

The Court held further that at the stage of justification of the infringement, the government must demonstrate both that the process by which it allocated the resource and the actual allocation of the resource which results from that process reflect the prior interest of aboriginal rights holders in the fishery but that the content of the prior interest (something less than exclusivity) will remain vague pending further decisions. The Court identified objectives such as the pursuit of economic and regional fairness and recognition of the historical reliance on and participation in the fishery by non-aboriginal groups as potentially justifiable limits on aboriginal rights which are not internally limited.

To date, the Supreme Court of Canada has not found an aboriginal right to fish for salmon either to exchange fish for money or other goods or to sell fish commercially. The Court, however, has recognized an aboriginal right to fish for salmon for food which includes social and ceremonial purposes. In *Gladstone,* the Court found that the Heiltsuk had established an aboriginal right to trade herring spawn on a commercial basis.

E. CONSULTATION WITH FIRST NATIONS

Government activity, particularly in the area of resource management and in relation to the use of Crown land generally, may affect the exercise of aboriginal rights. To fulfil its obligation to act honourably toward First Nations, the government's current practice is to make every effort to avoid infringing known aboriginal rights. These efforts include establishing whether aboriginal rights exist in an area affected by government action and determining whether the government action will infringe those rights. The province consults with the affected First Nation or Nations in attempting to determine both whether aboriginal rights exist and the effect of government activity on those rights.

If it appears that the proposed government action and the aboriginal right cannot co-exist and the resulting infringement cannot be justified under the tests set out in *Sparrow* and *Gladstone,* it is the current practice of the province to attempt to resolve the conflict and reach a negotiated settlement.

Where conflict between government action and aboriginal rights remains after the consultation and negotiation process, this conflict ultimately could be resolved either through court action or the treaty negotiation process.

The current practice of the province is illustrated in an agreement that relates directly to the subject of salmon aquaculture, the Memorandum of Understanding between the Province of British Columbia, as represented by the Ministers of Agriculture, Fisheries and Food and Environment, Lands and Parks, and the Kwakiutl Territorial Fisheries Commission, which is discussed below.[26] The agreement establishes a process for communication, consultation and information sharing between the ministries and the Kwakiutl Territorial Fisheries Commission regarding the disposition of Crown land and the management of aquaculture and aquatic resources in the area asserted to be the traditional territories of the First Nations affected by the agreement.

Since the agreement was signed, there have been a number of referrals regarding aquaculture operations made to the Kwakiutl Territorial Fisheries Commission and concerns have been raised about some of the sites according to the terms of the agreement. In some cases, but not all, the concerns raised have resulted in tenure not being granted.[27]

F. MODERN TREATY MAKING PROCESS

Treaty rights negotiated through the contemporary treaty negotiating process in the province will be accorded constitutional protection by virtue of section 35. Modern treaty rights will be amendable only in accordance with the amending formula contained in the treaty itself. It is also possible although not at all certain that constitutional protection will extend to legislation enacted under a treaty, such as implementation legislation.

Depending on the provisions of the treaty ultimately negotiated, the treaty may contain all the rights, whether exclusive or non-exclusive, of the First Nation in relation to particular lands or areas and subsume and extinguish aboriginal rights. On the other hand, the terms of the treaty may preserve specified or unspecified aboriginal rights apart from the treaty.

In addition, treaties may contemplate side agreements among a First Nation, the province and the federal government which, by express terms, do not have constitutional protection. These side agreements might be in relation to commercial or fiscal arrangements or transitional measures.

The treaty negotiating process in the province entails a Framework Agreement stage and an Agreement-in-Principle stage. Because they are not final treaties and are part of the negotiating process, these agreements almost certainly do not fall under section 35. The only First Nation with which agreement-in-principle has been reached is the Nisga'a Nation.

G. AGREEMENTS WITH FIRST NATIONS

The province and a number of First Nations have entered into a variety of different types of agreements which are not intended to be agreements, treaties or settlements within the meaning of Section 35 of the *Constitution Act, 1982*. These include Protocol Agreements, Memoranda of Understanding, Joint Stewardship Agreements, Interim Measures Agreements and Interim Protection Measures Agreements. The subject matter of some of these documents focuses on or includes fisheries and other natural resource issues.[28]

An example of an agreement that relates directly to the subject of salmon aquaculture is the Memorandum of Understanding between the Province of British Columbia, as represented by the Ministers of Agriculture, Fisheries and Food and Environment, Lands and Parks, and the Kwakiutl Territorial Fisheries Commission, which

was signed on December 10, 1993.[29] The purpose of the agreement is, among other things, to establish a clear, certain and timely process for communication, consultation and information sharing between the ministries and the Kwakiutl Territorial Fisheries Commission regarding the disposition of Crown land and the management of aquaculture and aquatic resources in the area asserted to be the traditional territories as identified by the First Nations affected by the agreement.

The agreement applies, among other things, to any future applications for aquaculture licences under the provincial *Fisheries Act* and to land tenures for aquaculture under the *Land Act*. The procedure agreed upon when the ministries receive an application for aquaculture tenure or an aquaculture licence includes the following steps:

- the ministries will notify the Kwakiutl Territorial Fisheries Commission of any applications using a special joint referral form from both the Ministry of Environment, Lands and Parks and the Ministry of Agriculture, Fisheries and Food;
- the Kwakiutl Territorial Fisheries Commission will refer the applications to the appropriate First Nations and attempt to respond in 30 days;
- the Kwakiutl Territorial Fisheries Commission will identify:
  - potential restriction on or interference with the right to fish for food, social or ceremonial purposes, the right to hunt or conduct cultural activities, cultural and spiritual sites, and traditional hunting and gathering sites,
  - potential restriction on or interference with aboriginal rights and title and Treaty rights, and
  - if possible, ways to address potential restrictions and interference to the satisfaction of the First Nations;
- the ministries will ensure all applications are dealt with in a way that is consistent with the legal obligation of the province to the First Nations and that the concerns and recommendations of the First Nations will be considered in good faith; and
- the ministries will notify the Kwakiutl Territorial Fisheries Commission in writing about any decisions made in this process.

This agreement does not apply to any leases, licences or permits for aquaculture granted by the ministries under the *Fisheries Act* or *Land Act* prior to the signing of the agreement. It also does not apply to any amendments to, renewals for or replacements of licences granted under the *Fisheries Act* prior or subsequent to the date the agreement was signed. However, if the Kwakiutl Territorial Fisheries Commission believes that an existing tenure is interfering with its Aboriginal rights and interests, the Kwakiutl Territorial Fisheries Commission may:

- identify potential restriction on or interference with the right to fish for food, social or ceremonial purposes, the right to hunt or conduct cultural activities, cultural and spiritual sites, and traditional hunting and gathering sites;
- identify potential restriction on or interference with aboriginal rights and title and Treaty rights; and
- if possible, propose ways to address potential restrictions and interference to the satisfaction of the First Nations.

The agreement provides that, if the Environment and Lands Regions Division[30] of the Ministry of Environment, Lands and Parks receives this advice, it will ensure that the concerns and recommendations of the First Nations will be considered in good faith and will attempt to make appropriate modifications to the tenure when possible. The Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks also will notify the Kwakiutl Territorial Fisheries Commission in writing about any decisions made in connection with this procedure.

Another agreement, the *Clayoquot Sound Interim Measures Extension Agreement* between the province and the Hawiih hereditary chiefs of the Nuu-chah-nulth Central Region Tribes and the province,[31] provides First nations and other communities in Clayoquot Sound opportunities for input into resource management, including the management of aquaculture. This agreement amends and extends the *Interim Measures Agreement* which established the Central Region Board to deal with resource management and land use planning in Clayoquot Sound. One of the responsibilities of the Central Region Board is to review, at its discretion, any plan, application, permit, decision, report or recommendation made by any ministry, agency or panel dealing with a number of resource activities, including aquaculture.

IV. SITING OF SALMON FARM FACILITIES

A. TENURE ON PROVINCIAL CROWN LAND

Many concerns have been raised about the processes used to decide where salmon farms will be allowed and the actual siting of some of the farms.[32]

Most salmon farms in B.C. operate on provincial Crown land. Title to the foreshore of tidal waters, the area between the high and low water line which is exposed at low tide, is vested in the province.[33] In addition, while the general rule is that the boundaries of the province end at the low-water mark of the sea, bays, harbours, estuaries and other inland waters "within the jaws of the land" are within the boundaries of the province.[34] The Strait of Georgia, the Strait of Juan de Fuca and Johnstone Strait are within the jaws of the land in British Columbia.[35] The provincial Crown, therefore, owns the beds of these bodies of waters.

Anyone wishing to operate a salmon farm on provincial Crown lands, including subaquatic lands, must obtain tenure[36] of Crown lands for the purpose of aquaculture. The Ministry of Environment, Lands and Parks, Environment and Lands Regions Division, is the lead provincial agency responsible for the administration and allocation of Crown lands in B.C. Land is made available under the *Land Act*[37] for salmon aquaculture under three types of tenure—an investigative permit, a licence of occupation or a lease.

To be eligible to obtain tenure for an aquaculture facility, an applicant must be

- a Canadian citizen or a permanent resident 19 years of age or over,• a corporation registered in the province or incorporated under the laws of Canada,• a registered partnership, or• a non-Canadian who owns the adjacent upland.[38]

An application fee of $107.00, including tax, must be submitted to the regional office of the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks with the application for Crown land.

An investigative permit[39] allows for the temporary occupation of Crown land for the purpose of determining the feasibility of developing a salmon farm in the area. It allows the prospective salmon farmer to occupy the Crown land, for a period not exceeding one year, to conduct an investigation of the area and its resources. It does not allow the prospective salmon farmer to construct any permanent improvements on the site. An application for an investigative permit must include a sketch showing the location and size of the area and a written description of any investigative activities, including temporary improvements to be undertaken.[40] There is a $500.00 fee for this permit which is payable in advance.[41]

Obtaining an investigative permit for a site does not guarantee that the permit holder will receive a licence of occupation or a lease for that site in the future. However, the Regional Director of the Ministry of Environment, Lands and Parks will consult with the permit holder before issuing any other lease, licence of occupation or permit for any purpose in relation to that site.[42]

It is not necessary to obtain an investigative permit for a site prior to applying for a licence of occupation or a lease. As a practical matter, in recent years there have been relatively few applications for investigative permits for salmon farms.

Either a licence of occupation[43] or a lease[44] is required before the physical development of the salmon farming operation is permitted, including the construction of any permanent improvements.[45]

A licence of occupation has a 10-year standard term, with the option of a replacement licence after half the term has expired. A replacement licence of occupation also has a 10-year standard term with the option of another replacement licence after half the term has expired. The annual fee for a licence of occupation is calculated at 7.5% of the zone land value, with a minimum annual rent of $500.00. There is a rental discount of 60% for the first three years of the initial term.[46]

Currently, a licence of occupation is the most common form of tenure for salmon farms in B.C., rather than a lease.

A lease is the longest form of tenure available and is the only tenure under which the fish farmer may obtain a registerable interest in land. A lease has a 30-year maximum term, with the option of a replacement lease after half the term has expired. A replacement lease also has a 30-year maximum term with the option of another replacement lease after half the term has expired. The annual fee for a lease is 8% of the zone land value, with a minimum annual rent of $500.00. There is a rental discount of 60% for the first three years of the initial term.[47]

To begin the process of obtaining permission to operate a salmon farm on Crown land under a licence of occupation or a lease, an applicant places a posting notice at a conspicuous point on the upland, giving notice of the intent to apply for a disposition of Crown land for the purpose of salmon farming. The applicant then submits to the regional office of the Ministry of Environment, Lands and Parks a notice of intention to apply for a disposition of Crown land. The notice describes the area by way of a legal description or a distinctive geographic feature.[48]

The applicant for a licence of occupation or a lease may be required to provide public notice of the application if the Minister of Environment, Lands and Parks considers it in the public interest.[49] As a matter of practice, an applicant for a salmon aquaculture site is always required to advertise.

An application for a lease or licence of occupation, but not an investigative permit, must be accompanied by an Aquaculture Development Plan. The Plan must be reviewed and approved prior to the salmon farm beginning to operate. Included in the Aquaculture Development Plan is detailed information about matters such as

- a description of the location, including a map or chart reference number for the area of the proposed site,
- the overall area of the proposed site,
- the maximum stocking density that is anticipated at full operation,
- whether the farm will be a single or multiple year class operation,
- whether fish will be put aside for broodstock,
- the species to be grown,
- the specific type of operation,
- the volume of production,
- estimates, for each species to be raised, of the expected number of smolts or fingerlings to be stocked, the grow out period, the average individual fish weight at the end of grow out, and the expected losses over the grow out period,
- water quality factors, such as • whether the proposed area has a history of plankton blooms, • if there are nearby potential sources of water pollution, • whether a fallow area is proposed, • the type of sewage system to be used, • the type of feed to be used, • whether automatic feeders will be used, • whether antifoulants will be used on farm equipment, • how solid wastes, including mortalities and feed bags, will be disposed of from the site,

- maps and diagrams of the proposed operational facilities and layout, with schedules outlining the time frame for completing the facilities,
- a schedule of improvements,
- a schedule of production,

- factors relevant to site capacity, including details about • temperature, • salinity and dissolved oxygen, • annual tidal range, • minimum water depth below the net cages, • current speed, • potential exposure to wind and waves, and
- other coastal users in the area, specifically • the distance to the nearest marine fish farm, • whether the proposed operation is within 1 kilometre of the mouth of a salmonid bearing stream, a Native reserve, a park or ecological reserve, a designated boat anchorage, or an area used by recreational boaters, • whether the proposed site is within 125 metres of an intertidal or subtidal shellfish bed which is subject to commercial, recreational or Native harvest, • whether the proposed site is within 1 kilometre of a marine fisheries habitat such as herring or cod spawning, salmon holding or rearing areas, and • whether the proposed site is used for commercial fishing.[50]

The application for tenure is reviewed for completeness and compliance with the siting guidelines and other siting policies. A number of steps are taken prior to deciding whether or not to approve the site for tenure. The application is entered into the tenure administration system computer and any existing dispositions and pending applications are noted. The eligibility of the applicant is verified, including checking to ensure the applicant is in good standing with the Registrar of Companies if a company or society. Regional staff enter the application in the Crown Land Registry System and the Tenure Administration System, plot the application on the reference maps and check for any conflicts for the specific site. A copy is sent to the Crown Land Registry Branch for formal plotting on the digitized reference maps and preparation of a legal print of the application area.[51]

The Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks normally conducts a site inspection of the proposed location before deciding whether or not to grant tenure. The site evaluation for salmon aquaculture tenure includes reviewing

• public beach access, • the existence of natural hazards, • the potential impact on other resource activities, such as recreation, • the potential impact on adjacent land users and upland owners, • other potentially higher economic uses of the area, • the existence of contamination, • the impact on marine resources and coastal physical processes and how these might be mitigated • scenic concerns of the boating public, • the spacing requirements for farms, and • any concerns raised during the referral process or as a result of advertising the application for the proposed site.

The Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks decides whether or not to grant tenure after completing these steps, considering the public response to advertising the application, and referring the application to other government bodies, First Nations and other interested parties who are invited to comment on the application. The notice and referral process is discussed in more detail below.

New and replacement dispositions of Crown land normally are made by a direct offer to an applicant in response to an application from an individual party. However, in some circumstances, such as where there are competing applications for aquaculture for the same parcel, new dispositions are made by public competition. If competing

applications over the same parcel are for different uses, such as salmon farming and log handling, the disposition of the Crown land will be determined on the basis of the highest and best use of the land as decided by the Regional Director of the Ministry of Environment, Lands and Parks in consultation with other appropriate agencies.[52]

B. GUIDELINES FOR SITING AND SPACING OF FARMS

There are a number of siting and spacing guidelines that the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks identifies in its Aquaculture Policy. They are guidelines, rather than regulatory standards, and therefore allow for the exercise of some discretion in their application. The guidelines include the following provisions:

- applications will not be accepted in areas fronting and 1 km seaward of provincial parks and ecological reserves;
- all marine finfish lease and licence applications will be considered important based on the joint recommendation of the Ministry of Agriculture, Fisheries and Food, the Ministry of Environment, Lands and Parks, and the Department of Fisheries and Oceans;the spacing distance between a marine finfish lease or licence and a salmonid stream may be increased upon the joint recommendation of the Ministry of Agriculture, Fisheries and Food, the Ministry of Environment, Lands and Parks, and the Department of Fisheries and Oceans;
- the marine finfish spacing distance may be increased in respect to shellfish applications and tenures if concerns are received from adjacent shellfish farmers or applicants and if recommended by the Ministry of Agriculture, Fisheries and Food;[53]

    - 3 km from an existing finfish lease or licence with consideration given to existing lease or licence applications, existing investigative permits and existing investigative permit applications;
    - 1 km from the mouth of a salmonid stream;
    - 125 metres from an existing shellfish lease or licence, with consideration being given to an existing application for shellfish tenure; and
    - 125 metres from a wildstock shellfish bed
    - the marine finfish spacing distance may be increased in relation to wildstock shellfish beds upon the joint recommendation of the Ministry of Agriculture, Fisheries and Food and the Department of Fisheries and Oceans; and
    - the spacing between freshwater finfish leases and licences must be 1 km.

There are no spacing requirements for investigative permits. Where there are investigative permits issued for sites between fish farms and limited opportunities for any additional fish farms in that area due to spacing guidelines, the Regional Director may issue leases or licences to existing investigative permit holders only, issue leases or licences through public competition among the existing investigative permit holders, or issue leases or licences by direct offer or public competition.[54]

The Aquaculture Policy states that the Regional Director in the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks will consider relaxation of the finfish spacing guidelines if an application demonstrates that the proposal is technically sound and acceptable environmentally and socially. There have been concerns raised that the siting and spacing guidelines are not always followed. In some cases there have been complaints that the information provided in the application materials contains inaccuracies.[55] In other cases, it may be that the Regional Director has exercised the discretion to relax the guidelines, as noted above.

A series of five Coastal Resource Interest Studies were coordinated by B.C. Lands following the 1986 Finfish Aquaculture Inquiry, which recommended that these studies be undertaken by the province to direct finfish aquaculture into areas where conflict with other coastal users would be minimized. These studies identified potential resource or user conflicts that need to be considered when siting marine fish farms. The process involved mapping critical and important uses along the coast as identified by user groups as critical or important to their particular interests, making draft map presentations at public open houses and publishing final finfish aquaculture opportunity maps. Each colour coded map designates zones as:

- conditional, where the normal referral process applies,
- limited, where fish farm applications will only be accepted for review on written consent from agencies with conflicting interests, and
- no opportunity or high conflict, where applications normally will not be accepted.

This information has been used to assist in making decisions about where salmon farms may be located. However, the Coastal Resource Interest Studies were intended to be applied as guidelines to assist in siting rather than as regulatory standards.

There have been complaints that this process has not been effective in avoiding the siting of farms in no opportunity zones. One reason is that B.C. Lands was directed to process all applications for licences of occupation which were already initiated at the time these studies were completed.[56] Also, if an applicant for an investigative permit under section 14 of the Land Act applied for longer term tenure, such as a licence of occupation, prior to the release of the Coastal Resource Interest Studies the requirements of the opportunity map were not applied in those situations either. Only applications for investigative permits that were not converted to applications for longer tenure before the studies were released and all new applications have been subject to the requirements of the Coastal Resource Interest Studies.[57]

Another limitation of the application of the Coastal Resource Interest Studies is that they do not take into account the biophysical attributes of an area for salmon farming.

However, the Ministry of Agriculture, Fisheries and Food has been using biophysical site capability criteria and mapping to assess the capability of broader areas of the coast for finfish and shellfish aquaculture. The Ministry has reports and map folios for finfish culture capability for most of the coast except for the Gulf Islands and Indian Arm. It will have digital files by March 31, 1997.[58]

The biophysical mapping records information on a number of factors important for siting fish farms, including temperature, salinity and turbidity, oxygen saturation, phytoplankton and diseases, currents, biological net foulants, slope stability, depth, substrate, navigation hazards and visibility, exposure, snowfall, ice cover and avalanche expected, pollution, and predators.

There also is a computer-based modelling system under development by the Ministry of Agriculture, Fisheries and Food to support aquaculture. It will assess the local and regional impacts of aquaculture operations by modelling hydrodynamics, water quality, sedimentation and fish growth. A pilot model is being developed for the Broughton Archipelago.

There are a number of other provincial and federal initiatives that are not focussed primarily on aquaculture but provide information that is very useful in the siting of salmon farms. Examples include the provincial land use

planning process, land use and coastal planning initiatives, and resource inventory programs and fish habitat map products maintained on the federal Department of Fisheries and Oceans Internet site.[59]

Recently the province announced the Central Coast Land and Resource Management Process (LRMP) and the Queen Charlotte Islands (Haida Gwaii) LRMP. Both LRMPs involve areas with extensive coastlines. Therefore, the plans developed for each of these regions will cover the coastal as well as upland areas. The processes are expected to result in zoning that takes into account the use of coastal and water resources along with associated management guidelines and objectives for coastal areas and features.

The province also has assembled an interagency committee to discuss the development of a provincial coastal policy to ensure coastal area management gives priority to coastal-dependent uses, is consistent across jurisdictions and maintains the integrity of coastal ecosystems. The work of this committee will provide information and background for the province that will be useful in upcoming discussions with the federal government regarding the development of the Oceans Management Strategy under the new federal Oceans Act, which is discussed below.

C. NOTICE AND REFERRAL PROCESS

If the tenure is expected to affect the right of access of a riparian or upland owner, the applicant is required to obtain the written consent of the upland owner for the proposed use for the duration of the tenure. This must be submitted as part of the application for tenure. Applicants for a licence of occupation or lease are required to notify in writing adjacent tenure holders and landlords within one kilometre in either direction of the proposed salmon farm and about 300 metres inland.

The B.C. Lands Aquaculture Policy provides that all applications and development plans for licences of occupation and leases are referred to relevant government agencies, local governments and interest groups for comment. Referrals normally are made to the following parties:

- Ministry of Agriculture, Fisheries and Food, regarding the technical feasibility of the proposed operation and the biophysical capability of the site to support the proposed operation;
- Ministry of Environment, Lands and Parks regarding the impact on recreational fisheries and wildlife, the environmental impact and the monitoring requirements;
- Department of Fisheries and Oceans, regarding the impact on wild fish stock and fish habitat;
- Environment Canada, regarding water quality issues and impact on shellfish growing waters;
- Coast Guard, regarding any navigational hazards;
- Ministry of Forests, District Office, regarding impact on coastal logging or forest recreation;
- Local government authorities, regarding local planning and zoning designations, development permits, infrastructure support and the degree of public acceptability;[60]
- Ministry of Small Business, Tourism and Culture, regarding coastal tourism;
- First Nations, regarding any possible infringement on aboriginal rights;[61]
- Other interest groups, regarding the interests of other groups potentially affected, particularly those whose interests were identified in the Coastal Resource Interest Studies; and
- Parks Branch, regarding possible impacts, but only where the proposed salmon farm is close to a recreational area, proposed or existing ecological reserve, or existing park.[62]

The referral process is intended, in part, to determine the biophysical suitability of the proposed site for salmon farming and to assist in both the identification of potential adverse effects of allocating Crown land for a salmon farm and the prevention or mitigation of potential effects.

At the conclusion of the referral process, a summary is prepared and the responses evaluated to determine whether they are sufficient to affect the decision.

A number of concerns have been raised during the Salmon Aquaculture Review about the referral process including the following:

- inadequate resources in the agencies receiving referrals to review applications and provide a thorough response in a timely manner;
- information deficiencies or inaccuracies in the referral materials provided to other parties;
- lack of adequate scrutiny by reviewing agencies of the information submitted by applicants;

more than one agency reviewing the same issues resulting in duplication during the process;• inadequate time to respond to referrals;• insufficient consideration of the potential effects of fish farms on other resources, such as archaeological resources;[63]• siting occurring in areas where it appears to be inconsistent with siting guidelines, such as the distance from the mouth of a salmonid stream;• criteria by which applications are screened not apparent;• lack of information and understanding about why decisions have been made;• lack of coordination among various agencies;• the need to respond to a referral without knowing what other agencies concerns might be;• the high volume of referrals at times;• interested individuals and organizations both in and outside government not receiving referrals;• the need for a dispute resolution mechanism to resolve disputes during the approval process; and• referral process resulting in long delays in the adjudication of applications for tenure.

As noted above, these and other concerns will be reviewed and evaluated during the Salmon Aquaculture Review.

If the site is approved, the regional office of the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks issues a prospective salmon farmer the appropriate form of tenure, with terms and conditions which include

• the business terms of the licence of occupation or lease,• details of the permitted site development, including the number of net cages and other capital works,• the amount of the performance and clean up guarantee,• insurance requirements, and• any site specific or special conditions.[64]

After tenure is issued, a copy is placed on the file in the Ministry of Environment, Lands and Parks and a copy is forwarded to the Crown Land Registry Branch. Other interested parties also are advised when tenure has been issued.

D. Replacement Tenures

If the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks receives an application for a replacement licence of occupation or replacement lease, it normally does not repeat the full referral process followed at the time of an application for new tenure. However, a referral of the application for replacement tenure would be made to

- an agency that had expressed a concern about an issue within that agency's responsibility, during the time of the previous tenure,
- an agency responsible for an issue of concern where that issue had been brought to the attention of the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks by another party during the existing tenure period,
- the appropriate First Nations, in cases where there could be an infringement on the aboriginal rights of those First Nations, and
- the Regional Fish Farm Review Committee members.

During the period of the Action Plan for Salmon Aquaculture, tenure holders may apply to replace their existing tenures. These applications will be referred to the Regional Fish Farm Review Committee, as discussed below.

E. Tenure on Federal Lands

Public harbours are the property of the federal government. The federally owned public harbours in British Columbia are Esquimalt, Victoria, Nanaimo, Alberni, New Westminster and Burrard.

If a salmon farm operation is to be located on federal land in a public harbour or port, a Federal Waterlot Lease or Licence must

F. Navigable Waters

The Department of Fisheries and Oceans is responsible for the protection of navigable waters under the authority of the federal *Navigable Waters Protection Act*.[65] The Coast Guard is the government agency responsible for ensuring salmon farms comply with the provisions of this Act. Any salmon farm located on, under or over navigable waters or having improvements that could impede navigation must have the site, the plans and the specific works approved under that Act prior to construction.[66] The Act further provides that this requirement does not apply to any work that, in the opinion of the Minister of Fisheries and Oceans, does not interfere substantially with navigation.[67]

G. Local Government

Local government also may be involved in the siting of salmon aquaculture facilities. Local government has authority over matters such as planning and regulation of the use and development of land, including areas of Crown land or water surfaces where leases or licences of occupation have been granted. Under the *Municipal Act*,[68] local governments may state, in their official community plans, broad objectives, policies and guidelines respecting present and proposed land uses and development. These may be implemented using zoning bylaws, permits and other instruments. Regional districts and the Islands Trust also may use rural land use bylaws for planning and regulation of land, including the surface of water. [69] The power to regulate includes the power to prohibit any use or uses in any zone or zones.[70]

The B.C. Lands Aquaculture Policy provides that the siting of all aquaculture leases and licences will be consistent with local government bylaws at the time the tenure is initially granted.[71]

Some local governments have enacted zoning bylaws with specific provisions relating to aquaculture. For example, the Comox-Strathcona Regional District, an area in which a number of salmon farms are located, has electoral areas that have adopted bylaws reflecting different approaches to zoning for aquaculture.

The Cortes Island Zoning By-Law[72] designates four types of aquaculture zones. Two of those zones permit active aquaculture as one of the principal uses. Active aquaculture is defined in the bylaw as aquaculture activity involving active feeding, and using pens, net cages, or floats for net cages. Both zones permitting active aquaculture provide that, as a condition of use, no floating or fixed structures may prevent access by an upland owner to water or over the surface of water to navigable areas.[73] The two zones have different requirements regarding the size of the farm sites. One zone permits a maximum site area of 12.15 hectares or 30 acres and the other zone permits a maximum site area of 8.1 hectares or 20 acres.[74] The latter zone further addresses siting by providing that

> Site areas for finfish aquaculture may be located on the basis of a distance averaging formula. An average of one finfish aquaculture site per three kilometres of linear shore between Carrington Bay and Bullock Bluff as identified on Schedule 'A-7' shall be permitted with a minimum separation of one kilometre between finfish aquaculture sites.[75]

A zoning map for Cortes Island indicates where these aquaculture zones are located, showing large coastal areas where this activity is permitted.[76]

Zoning for the electoral area of Quadra Island, also in the Comox-Strathcona Regional District, has followed a different approach. The *Quadra Island Official Community Plan Bylaw, 1996* sets out policies for fisheries and aquaculture which expressly recognize the importance of the aquaculture industry as well as the need to ensure protection of sensitive areas and consider the impact on the environment, other uses and the community. The policies also state that the management, protection and enhancement of foreshore values can be most effectively accomplished through direct and active consultation between the appropriate government agencies and the community.[77]

The Quadra Island Zoning By-Law permits active aquaculture, described as involving the administration of feed and chemical products and using generators and netpens or floats for pens, in one of its zoning designations. A zoning map for Quadra Island identifies these active aquaculture zones, showing very specific coastal locations where this activity is permitted. These locations reflect the areas where salmon farms were already located at the time the zoning was adopted.[78] Any areas in this electoral area that have no other designated zoning and are outside the Rural Land Use Planning Area are considered to be zoned, in the case of foreshore areas and the surface of the water, in a designation permitting only navigational aids and recreational shellfish gathering and harvesting. Therefore, a proposed new salmon farm site would require a change in zoning to permit active aquaculture, a process that would involve a public hearing.

Electoral area J in the Comox-Strathcona Regional District has adopted a Rural Land Use Bylaw for Desolation Sound [79] which also includes a designation for active aquaculture, described as involving the administration of feed and chemical products and using generators and netpens or floats for pens. The bylaw states that active shoreline developments will be reviewed on a site-specific basis through open communication and referral between the community and all government agencies whose interests may be affected. It also provides that temporary aquaculture permits will be considered if certain conditions are met, including returning the site to its original condition if aquaculture zoning does not occur, with security to guarantee completion of the rehabilitation of the site.

The Regional District of Mount Waddington includes the Broughton Archipelago, the study area for the Salmon Aquaculture Review. The general zoning bylaw for the Regional District of Mount Waddington[80] does not designate aquaculture zones, nor does it restrict finfish farming. The Official Regional Plan contains only general language about commercial development and nothing specific to salmon farming.[81]

However, the Malcolm Island Official Community Plan, adopted January 15, 1997, establishes an aquaculture policy to exclude finfish farms unless located on land. It provides as follows:

PO.65 Except for the harvesting of natural ocean products aquacultural pursuits will be permitted only if demonstrated to benefit the economy of the Island and, proven ecologically safe and will exclude finfish farms, unless located on dry land.[82]

The Regional District of Alberni-Clayoquot permits aquaculture in four designated zones. Aquaculture is defined as the cultivation, rearing, harvesting and processing of aquatic organisms on land or in non-tidal waters for commercial gain or sale as food or a food product for human or animal consumption. Three of the designated zones permitting aquaculture allow upland aquaculture only. The fourth zone permits both upland aquaculture and foreshore and water-based aquaculture. Zoning requirements for all zones permitting any form of aquaculture provide that nothing is to be done that will become an annoyance or nuisance to the surrounding areas by reason of unsightliness, the emission of odours and noise including generator or pump noise and the use of floodlighting.[83]

The Regional District of Alberni-Clayoquot participated in the development of the Barkley Sound Planning Strategy. The strategy has been adopted as a policy statement by the directors of the Alberni-Clayoquot Regional District.[84] The purpose of the Strategy is to guide the long-term use, development and management of the lands and resources of Barkley Sound and Alberni Inlet. It is intended to provide a guide for decision-making and does not alter the statutory authority of participating parties. In the section dealing with resource industries, the Strategy states that aquaculture priority areas have been designated in recognition of the high suitability for such uses, but without limiting aquaculture elsewhere. One of the objectives in this section calls for reserving sites which are particularly suited to aquaculture. The guidelines for fish farms state that sites for current and future finfish farms should be maintained in San Mateo Bay, Jane Bay, Effingham Inlet, Alberni Inlet and other areas where appropriate and that conversion of existing fish farm leases to non-aquaculture uses should not be permitted.[85]

H. Other Provincial Laws Relevant to Siting

Farm Practices Protection (Right to Farm) Act and Municipal Act

A new piece of provincial legislation has the potential to affect some aspects of salmon farming in the future, including aspects related to siting and operating practices. The *Farm Practices Protection (Right to Farm) Act*,[86] passed in 1995, provides a number of measures to protect farming in British Columbia and makes consequential amendments to the *Municipal Act*[87] and the *Land Title Act.*[88]

If the requirements of the Act are followed on a farm operation, a farmer cannot be sued in nuisance for any odour, noise, dust or other disturbance resulting from the farm operation and a farmer cannot by injunction or other court order be prevented from carrying on that farming operation.

In addition, if the requirements of the Act are met, a municipal council or regional district may not enforce against a farmer bylaws made under sections 703, 704, 724, 725, 728 or 799(1)(a) or (b) of the *Municipal Act*.[89] Those sections authorize bylaws dealing with issues such as prohibiting noise, odours, unsightly premises or the discharge of firearms.[90]

Under the Act, farm operations include aquaculture as defined in the provincial *Fisheries Act* when carried on by a party licensed under that Act. This section of the Act which defines a farm operation to include aquaculture came into force on April 1, 1997, later than the rest of the Act.[91]

Since the Act applies to aquaculture operations, a salmon farmer is entitled to the protections noted above provided that the farm operation is conducted

- according to normal farm practices,[92]
- under a valid aquaculture operating licence issued under the *Fisheries Act,*
- in compliance with the *Health Act*, the *Pesticide Control Act*, the *Waste Management Act*, and the regulations under those Acts, and
- in compliance with any land use regulation, which means an enactment that restricts or prescribes the use to which land or premises may be put or the nature of business or activities that may be conducted on land or premises but does not include a bylaw under sections 703, 704, 724, 725 or 728 of the *Municipal Act.*

Instead of bringing an action in nuisance or enforcing bylaws made under sections 703, 704, 724, 725, 728 or 799(1)(a) or (b) of the *Municipal Act*, it is possible to bring a complaint about odour, noise, dust or other disturbance from a farm operation to the Farm Practices Board, which is established by this Act. The Board will determine whether or not the practice complained about is a normal farm practice. If the Board finds that

it is a normal farm practice, it must dismiss the complaint. If the Board finds it is not a normal farm practice, it must order the farmer to cease the practice or modify it to be consistent with normal farm practice.

The Ministry of Agriculture, Fisheries and Food currently is developing operating standards, in consultation with industry and local government, that would be used, in part, to determine what constitutes normal farm practice for aquaculture under this Act.

The *Farm Practices Protection (Right to Farm) Act* also amended the *Municipal Act* with provisions that affect local government's regulation of aquaculture operations.

First, a community plan may include policies of the local government to maintain and enhance farming on land in a farming area.[93] The *Municipal Act* has been amended to define a farming area to include an area of land that is affected by a valid and subsisting licence, for aquaculture, under the *Fisheries Act.*[94]

Second, the Minister of Agriculture, Fisheries and Food may establish standards[95] to guide local government in the preparation of rural land use bylaws, zoning bylaws and farm bylaws as referred to in the new Act.[96]

Third, the Lieutenant Governor in Council may declare by regulation that specific new provisions of the Municipal Act apply to a board of a regional district, the council of a municipality or the local trust committee of a local trust area within that regional district to

- prevent a board from using a rural land use bylaw to prohibit or restrict uses of land for a farm business in a farming area,[97] which as noted above includes an area with a valid and subsisting licence for aquaculture under the *Fisheries Act*, unless the board receives approval from the Minister of Agriculture, Fisheries and Food,
- prevent a local government from implementing zoning bylaws to prohibit or restrict the use of land for a farm business in a farming area unless the local government receives approval from the Minister,[98]
- subject to the approval of the Minister, allow a local government to make bylaws in relation to farming areas governing • the conduct of farm operations, • the types of buildings and equipment to be used, • siting of stored materials and waste facilities, and • specifically prohibited farm operations

  and allows these bylaws to be different for different sizes or types of farms, types of farm operations, site conditions, uses of adjoining land or areas.

Fourth, if a regulation has been passed applying these sections to a specific board of a regional district, a specific council of a municipality, or a specific local trust committee, the local government must review all rural land use bylaws and zoning bylaws to identify if any are inconsistent with standards established by the Minister under section 916 of the *Municipal Act.* During the first three years after such a regulation is passed, a board, a council or a local trust committee may amend, by bylaw, its rural land use bylaws or zoning bylaws to achieve consistency with standards established by the Minister of Agriculture, Fisheries and Food under section 916 of the *Municipal Act*. An amending bylaw for this purpose may be adopted without public hearing.[99] However, the Act does not compel a local government to actually achieve consistency with standards set by the Minister.

Therefore, if a salmon farm has a valid aquaculture licence, when a local government wishes to make bylaws affecting that farm it will have to determine whether these new sections of the Municipal Act apply to it and, if so, will have to obtain the approval of the Minister of Agriculture, Fisheries and Food before adopting new bylaws that would restrict or prohibit farm use.

Heritage Conservation Act

Fish farm operations have the potential to conflict with archaeological resources protected under the provisions of the *Heritage Conservation Act*. [100] Most coastal archaeological sites are located on upland areas close to the shoreline. Some, such as canoe skids, fish traps and petroglyphs, are found within the inter-tidal zone and others, such as shipwrecks, are subtidal.

The *Heritage Conservation Act* provides for the protection of objects and land, including land covered by water, that have heritage value to British Columbia, a community or an aboriginal people. Heritage value is defined as the historical, cultural, aesthetic, scientific or educational worth or usefulness of a site or object. The Act provides a number of mechanisms to achieve heritage protection and prohibits damaging or altering designated heritage sites except as authorized under the Act. The Act also authorizes a heritage inspection or heritage investigation to be conducted in certain circumstances.

Archaeological sites are protected by the Act when designated as provincial heritage sites. Also, in some cases they are protected by virtue of being of particular historic or archaeological value. Protected archaeological sites may not be damaged or altered without a permit.

Therefore, if a prospective site for a salmon farm had the potential to interfere with an archaeological site protected under this Act, it would be necessary to comply with the provisions of the Act.

The *Heritage Conservation Act* is binding on the provincial government and takes precedence over other legislation.

Water Act

If a salmon farm requires fresh water for its operations that is drawn from a surface source, the operator may be required to obtain a licence under the provincial *Water Act*.[101] This Act is the chief provincial law controlling the use of fresh water. Its focus is on regulating quantities of water through a licensing system. In general, the provincial Crown owns the water, subject to licences or permits issued or approvals given under the Act. The Water Management Branch of the Ministry of Environment, Lands and Parks provides approvals which authorize all changes to natural watercourses and licences for the diversion, storage and use of water.

The *Water Act* does not regulate the use of groundwater in the province. However, a salmon farm could be considered a reviewable project under the provincial *Environmental Assessment Act* and subject to review under that Act if facilities on a new salmon farm had the capacity to extract groundwater at a rate of 75 litres or more per second.[102]

Waste Management Act

A number of provisions of the *Waste Management Act* and regulations adopted under its authority have implications for siting. The Act and the relevant regulations are discussed below in the section of this report dealing with waste discharges.

I. Other Federal Laws Relevant to Siting

Section 35(1) of the federal *Fisheries Act*[103] prohibits the harmful alteration, disruption or destruction of fish habitat. Fish habitat is defined to mean spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes. A person will not be liable under this provision if that person alters, disrupts or destroys fish habitat under conditions authorized by the Minister of Fisheries and Oceans or under regulations. The proposed revisions to the *Fisheries Act*, if brought into force, will permit delegation to provinces of certain habitat management responsibilities.[104]

The *Oceans Act*,[105] which was granted Royal Assent on December 18, 1996, consolidates Canada's ocean related legislation. Part II of this Act provides the legislative framework for a new strategy to manage oceans based on the principles of ecosystems based integrated management, the sustainable development of ocean resources and the precautionary principle. It authorizes the development and implementation of a strategy and integrated management plans for estuarine, coastal and marine ecosystems. The Act is intended to involve stakeholders in developing specific mechanisms, planning, guidelines and standards required to bring about sustainable use of the oceans. This process could be relevant to the siting of salmon farms and other aquaculture operations, depending on their location.

The federal Department of Fisheries and Oceans currently is developing guidelines for siting and operating aquaculture facilities. These are expected to be completed within the next year. They will be used to assess referrals made to the Department for new sites. They also are intended to assist possible salmon aquaculture operators in selecting potential sites for new salmon farms.[106]

J. International Initiatives Relevant to Siting

There are a number of international initiatives that have the potential to affect the siting of salmon farms. Following is a brief description of some of these initiatives.[107]

The comprehensive *Law of the Sea Treaty*[108] contains obligations relating to protecting the marine environment, protecting living marine resources and conserving anadromous fish stocks. Article 66 sets out the regime for management of anadromous species and provides that states of origin of anadromous stocks have the primary interest and responsibility for those stocks. The Treaty has been

ratified by the required number of signatory countries. However, Canada has not yet enacted federal legislation to allow the provisions to be implemented completely and enforced domestically.

The International Union for the Conservation of Nature (IUCN) held its first World Conservation Congress in Montreal in October, 1996. The Congress passed resolutions promoting marine protected areas, coastal and marine conservation and management and protection of fisheries and marine biodiversity. A resolution regarding aquaculture was adopted at the October Congress. A copy of the final adopted version of the resolution is attached as Appendix A.

The International Council for the Exploration of the Sea (ICES) is an intergovernmental marine science organization. Its principal functions include promoting marine research, disseminating results of the research, and providing advice and information to regulators for the protection of the marine environment and for fisheries conservation. ICES has addressed issues related to marine aquaculture. For example, ICES has developed a *Code of Practice on the Introductions and Transfers of Marine Organisms.*[109]

A B.C./Washington Environmental Cooperation Agreement was signed in 1992 to address transboundary environmental issues, to ensure coordinated action and to promote information sharing. It has addressed topics such as habitat loss and marine protected areas.

V. Operating Licences

A. Initial Application

As well as obtaining approval for the physical siting of a salmon farm, anyone who carries on the business of salmon aquaculture in the province or its coastal waters must hold an aquaculture licence to operate a salmon farm issued under the provincial *Fisheries Act*.[110] The Ministry of Agriculture, Fisheries and Food is the lead provincial body responsible for the administration of licences for salmon aquaculture operations under the authority of the provincial *Fisheries Act* and the *Aquaculture Regulation*.[111]

For salmon farms located on provincial Crown land, the Aquaculture Development Plan submitted to the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks will be forwarded to the Ministry of Agriculture, Fisheries and Food during the review of the application for tenure. It will be reviewed during that exercise and approved if satisfactory. The contents of an Aquaculture Development Plan are described in detail earlier in this paper.

However, if the proposed salmon farm will operate on private land or on land not administered by the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks, an Aquaculture Development Plan will have to be submitted to the Ministry of Agriculture, Fisheries and Food along with the application for an operating licence.

An application for a new aquaculture licence or a renewal of an aquaculture licence must be made in writing to the Minister of Agriculture, Fisheries and Food. An aquaculture licence, when granted, is valid for one year from the date it becomes effective. A separate aquaculture licence is required for each salmon farm location.

The *Fisheries Act* provides that the licence must include

- the name and address of the licence holder,
- the location of the area in which the licensed activity is to be carried on,
- the effective date and term of the licence, and
- other terms and conditions the Minister considers appropriate.[112]

B. Terms of the Licence

The scope and type of these terms and conditions are not defined or limited in the Act. Therefore, there is broad scope to attach a variety of conditions to the licence. An example of a licence is attached as Appendix B.

Each licence is subject to a variety of general and site specific terms and conditions. Specifically, each aquaculture licence is subject to

- the *General Terms of an Aquaculture Licence*,
- the Aquaculture Development Plan filed with and approved by the Aquaculture and Commercial Fisheries Branch, and
- any terms and conditions that are attached as Special Provisos.

Special Provisos are terms and conditions designed specifically for the salmon farm receiving the licence and address any particular concerns in relation to that site. They may cover a broad range of issues such as predator control or the transport of live fish from a hatchery to a salmon farm.

Some of the requirements of the provincial *Aquaculture Regulation* are included as conditions of an aquaculture licence and, therefore, may be enforced under either provisions of the Regulation or under the licence.

Conditions contained in licences for salmon farming include provisions such as those noted below, requiring the licence holder to comply with its approved Aquaculture Development Plan,

- obtain an approved amendment to its Aquaculture Development Plan for an increase in production greater than 20% or for a change in the mode of operation,
- raise only the species listed in the licence, after obtaining all necessary authorizations for import and transplant,
- take reasonable precautions to prevent escape and report escapes that occur,
- ensure no one deliberately releases fish without authorization,
- report escapes,
- ensure fish are given care and attention consistent with their biological requirements,
- employ reasonable practices for preventive predator control,
- employ reasonable practices for preventive disease control,
- keep and make available records to verify compliance with the terms of the licence, the *Aquaculture Regulation* and the provincial *Fisheries Act*,
- possess a valid processing licence before processing fish at the site of the aquaculture licence,
- ensure that the aquaculture facility is operated in accordance with standards established by the Aquaculture and Commercial Fisheries Branch in consultation with industry, and
- comply with all laws, bylaws and orders of any government authority which affect the aquaculture facility.[113]

The *Fisheries Act* contains broad powers for the Minister to require licence holders to submit reports in a manner and form and at intervals that may be specified by the Minister.[114]

C. Suspending or Revoking a Licence

The Minister is authorized to suspend or revoke a salmon farm licence, in addition to all other available penalties, if the holder violates a provision in Part 3 of the *Fisheries Act*, the regulations or a condition of the licence. Before suspending or revoking the licence, the Minister must conduct an investigation. The Minister also must hold a hearing if requested to do so by the licence holder. The Minister must preside at the hearing and has the same powers as the Supreme Court regarding witnesses and evidence.[115] In addition to all other available penalties, where a licence has been revoked or there has been a violation of a provision in Part 3 of the Act, the

regulations or a condition of the licence, the Minister may refuse after that to issue a licence under this Act to that licence holder.[116]

The power to suspend or revoke a salmon farm licence has not been used to date. In some cases, however, the Ministry of Agriculture, Fisheries and Food has refused to issue renewal licences unless licence violations have been rectified.[117]

D. Proposed Standards of Operation

For some time it has been contemplated that standards for the operation of different types of aquaculture facilities would be developed by the Ministry of Agriculture, Fisheries and Food in consultation with the industry and other government agencies. For instance, written materials explaining the General Terms of an Aquaculture Licence make reference to the development of operating standards to deal with issues such as preventive predator control, preventive disease control and disease treatment.[118] Operating licences issued under the provincial *Fisheries Act* could then be made subject to compliance with those operating standards and the standards enforced in the same way as any other term or condition of the licence.

Although some work has occurred in the development of operating standards, there are no standards in effect at present. The need to determine normal farm practice for the purposes of the *Farm Practices Protection (Right to Farm) Act*, as discussed above, may accelerate completing these operating standards. However, it is not clear if they will be regulatory standards or guidelines.

E. Transfer of Existing Licence

The provincial *Fisheries Act* provides that licences are not transferable except when there has been a change of ownership and the Minister agrees to a transfer of the licence to the new owner. The applicant makes a request to the Ministry of Agriculture, Fisheries and Food for a letter of consent regarding the licence to be transferred. This letter also is sent to the appropriate office of the Ministry of Environment, Lands and Parks.

The Aquaculture and Commercial Fisheries Branch will consent to the transfer of the licence if the following conditions are met:

- the site has not been reassigned within one year;
- the site is being used diligently;
- the site is currently licensed by the branch;
- the assignee or new owner agrees to operate the salmon farm according to the existing approved Aquaculture Development Plan.

F. Renewal of a Licence

On receiving an application for renewal of an aquaculture licence, staff of the Ministry of Agriculture, Fisheries and Food check to determine if the licence fees are paid and if there are any licence infractions on record before issuing a renewal licence. If needed, additional conditions may be attached to the licence prior to renewal.

VI. ESCAPED FARM FISH

Many concerns have been raised about the possibility that farmed salmon may escape into marine and freshwater environments.[119] The *Aquaculture Regulation* prohibits the release of fish from a salmon aquaculture facility unless the release is authorized by the aquaculture licence.[120] It also requires a licence holder to take reasonable precautions to prevent accidental escape of farmed fish.[121] As well as being regulatory standards, these requirements are included as conditions of each salmon farm's aquaculture licence.

The *Aquaculture Regulation* further requires a licence holder to report orally to the manager of aquaculture[122] within 24 hours an escape of fish from an aquaculture facility. A licence holder also must report an escape in writing within one week of discovery if requested by the manager of aquaculture.[123]

The *Fishery (General) Regulations*, adopted under the federal *Fisheries Act*, prohibit the release of live fish to any fish habitat, unless the release is authorized under a licence issued by the Minister of Fisheries and Oceans.[124] This section addresses the intentional release of fish rather than the unintentional escape of farmed fish. The Minister may only issue a licence if

- the release would be in keeping with the proper management and control of fisheries,
- the fish do not have any disease o0y 0 0.753 scn0.2951 -0.0437 TD(n)Tj0 0 0 scn-0.0437 0.0437 Tndo

- maintaining a public access information line for the reporting of Atlantic salmon.[129]

In 1995, 648 Atlantic salmon were either returned or reported to the Department of Fisheries and Oceans from marine fisheries and 82 Atlantic salmon were reported sighted or captured in freshwater. During that year 163 fish were returned to the Pacific Biological Station for analysis and species verification. In all, 92% of the reported Atlantic salmon catch was caught in Johnstone Strait. Twenty-two Atlantic salmon were reported caught in Alaskan commercial fisheries in 1995 and 63 were reported caught in Washington State.[130]

vii. Fish Health

A. Transport of Fish

Some concerns related to fish health[131] arise because of the need to transport live fish for salmon farming within the province, such as when smolts are transported to a grow out facility. The need to transport live fish also increases the chances that farmed fish may escape.

At the provincial level, the *Wildlife Act* prohibits anyone from shipping or transporting fish from or in non-tidal waters, including eggs and juvenile fish, except where authorized by regulation.[132] For the purposes of this Act, fish are defined as any

(a) vertebrate of the order Petromyzontiformes (lampreys) or class Osteichthyes (bony fishes), or

(b) invertebrate of the class Crustacea (crustaceans) or class Mullusca (mollusks) from or in non-tidal waters of the Province, and includes their eggs and juvenile stages.[133]

The *Wildlife Act* specifically authorizes the Lieutenant Governor in Council to make regulations "controlling the transportation in the Province of wildlife or fish or parts of them."[134] The provincial *Freshwater Fish Regulation*,[135] adopted under the provincial *Wildlife Act*, requires anyone transporting live fish to obtain a permit. In that Regulation, fish are also defined as a freshwater species of lampreys or bony fishes and their eggs and juvenile stages.

In addition, the provincial *Aquaculture Regulation*, adopted under the provincial *Fisheries Act*, requires a person who transports fish on, over or through fresh or tidal waters to take reasonable precautions to prevent the escape of the fish.[136]

The *Fishery (General) Regulations*, adopted under the federal *Fisheries Act*, prohibit the transfer of any live fish to any fish rearing facility unless the transfer is authorized under a licence issued by the Minister of Fisheries and Oceans.[137] The Minister may issue a licence only if

- the transfer would be in keeping with the proper management and control of fisheries,

- the fish do not have any disease or disease agent that may be harmful to the protection and conservation of fish, and
- the transfer will not have an adverse effect on the stock size of fish or the genetic characteristics of fish or fish stocks.[138]

Also at the federal level, the *Fish Health Protection Regulations*[139] were brought into effect under the authority of the federal *Fisheries Act* to address concerns about possible fish disease transfer due to the movement of live fish and fish eggs into the country and across provincial boundaries. The Regulations provide that no one may import cultured fish or eggs of wild fish without an import permit. An import permit may be issued only where the person who applies for the permit has obtained a certificate from a fish health official.

If live cultured fish are being imported, which is not normally the case for farmed salmon in British Columbia, the certificate must certify that

- the fish come from a source that was inspected and found to be free of any disease or disease agent listed in Schedule II of the Regulations, and
- no fish, other than fish from a source referred to above, have been introduced to the source of the importation within two years immediately preceding the date of the certification.

If eggs of wild fish are being imported, the certificate must certify that the eggs were taken from wild fish that were inspected and found to be free of any disease or disease agent listed in Schedule II of the Regulations.[140]

The required certificate must list the presence of any disease or disease agent listed in Schedule IV of the Regulations[141] that has been detected in the fish during the prescribed inspection. The import permit must not be issued unless the local fish health officer is satisfied that any disease or disease agent listed in Schedule IV that has been detected on the live cultured fish or the wild fish eggs will not be harmful to the protection or conservation of fish in the province.

The Department of Fisheries and Oceans now pays all the costs for health certification under the Regulations. However, it intends to begin recovering these costs.[142]

Amendments to the *Fish Health Protection Regulations* have been under discussion since 1990 and currently are being planned for introduction in two phases.

The *Regulations Amending the Fish Health Protection Regulations*, the first set of amendments, were published in the *Canada Gazette*, Part I, on January 4, 1997.[143] The purpose of these proposed amendments is to

- allow local fish health officers to approve transfers of eggs and fish between sites, even when disease agents of concern are detected at the source, and
- allow local fish health officers to approve the transfer of disinfected eggs from source facilities or wild broodstocks that have only been tested for viruses.[144]

These amendments are not intended to supersede or cancel any regional or provincial fish health protection policies that may be more stringent.

More extensive amendments to the *Fish Health Protection Regulations* are expected to be introduced in 1998. The changes being considered include the following:

- extending the application of the Regulations to all finfish species, since they currently apply only to salmonid species;
- deleting Enteric Redmouth Disease from the Regulations on the premise that effective vaccines and management practices to control this disease are readily available;
- adding Oncorhynchus Masou Virus to the list of diseases of concern;
- adding schedules for indigenous fish diseases on a province by province basis;
- requiring mandatory reporting of diseases listed in the *Fish Health Protection Regulations* when a disease is new to a province;
- providing the authority to quarantine facilities to prevent the spread of fish diseases that are new to a province; and
- providing the authority to prohibit the import of live fish, eggs and uneviscerated dead fish from areas reporting new diseases unknown in Canada as a short-term emergency measure.

In 1993, the federal Department of Fisheries and Oceans and the provincial Ministries of Environment, Lands and Parks and Agriculture, Fisheries and Food signed the Memorandum of Understanding Regarding the Fish Transplant Committee to deal with concerns about disease, genetic, ecological and other factors associated with importing and transferring live fish[145] into B.C. The agreement authorizes the Fish Transplant Committee to assess risks connected with fish transfer and to make recommendations to fisheries management agencies of both governments on the granting of fish movement permits and licences.

More specifically, the Fish Transplant Committee is required to make recommendations on ways to minimize the risk of potential fish diseases or genetic or ecological effects upon fish that may result from any movement by people of live fish into and within B.C. To carry out its mandate, the Fish Transplant Committee must review applications for transplants made under the federal *Fishery (General) Regulations*, the provincial *Freshwater Fish Regulation* or the provincial *Fisheries Act* and make recommendations regarding permitting and licensing. It is also authorized to make recommendations regarding transplant policies. The Memorandum is in effect for five years but can be amended at any time upon the agreement of the parties.

In March, 1992, the federal Department of Fisheries and Oceans instituted a new *Policy for the Importation of Atlantic Salmon into British Columbia*.[146] It was developed in recognition of the importance of protecting the commercial fisheries, recreational fisheries and cultured fish stocks of

B.C. from the importation of non-indigenous disease agents and parasites. It requires all proposals to import Atlantic salmon into B.C. to be assessed and authorized by the Department of Fisheries and Oceans on the basis of a protocol set out in the Policy. The Department of Fisheries and Oceans states in the Policy that it will consult with the provincial Ministries of Agriculture, Fisheries and Food and Environment, Lands and Parks on all decisions made under this Policy.

The protocol in the Policy includes the following provisions:

- each importation must comply with the federal Fish Health Protection Regulations;
- only surface-disinfected, fertilized eggs will be imported and no live fish or unfertilized eggs will be imported;
- importation of milt is allowed if the broodstock from which the milt is collected complies with the federal Fish Health Protection Regulations, 100% of the ripe males from which the milt is collected are sampled for the viral disease agents of concern and eggs fertilized with imported milt are held under quarantine according to the procedures in the Policy;
- egg imports are allowed only from broodstock that has been held in captivity by the source facility for one full generation; the eggs (with eyes) must arrive in B.C. a minimum of 15 days before they hatch;
- importations are allowed only from facilities • inspected and approved by a local fish health officer[147] at least 15 days prior to the eggs or milt arriving in B.C., • where there is a program of regular fish health monitoring and documentation by a fish health official approved to inspect fish sources under the federaled

Exceptions to this policy are permitted to overcome unexpected domestic egg supply shortages and for scientific research and development purposes.

B. Disease Control

Site Practices

Other concerns connected to fish health arise from the susceptibility of farmed salmon to disease and the risk of transmission of disease to other farmed salmon or to wild fish stock.

The provincial aquaculture operating licence issued by the Ministry of Agriculture, Fisheries and Food requires a salmon farmer to undertake reasonable and lawful practices necessary for disease control.[150]

At the provincial level, the *Animal Disease Control Act*[151] provides the statutory authority to limit the spread of infectious or contagious diseases in all stages of development. The Act contains measures to deal with animals that are diseased or appear to be so. Animals are defined by regulation to include aquatic animals cultivated for commercial purposes in any water environment, including fabricated containers of water, or in or under the foreshore.

The Act defines diseased as being infected with an infectious or contagious disease. Infectious or contagious disease means the specific diseases listed in the Act or any other disease that the Lieutenant Governor in Council declares to be an infectious or contagious disease.[152] However, at this time, none of those diseases are specific to aquatic animals.

If a salmon farmer had fish which appeared to be diseased with one of the diseases regulated under the Act, the farmer would be required to notify the nearest inspector or the Minister of Agriculture, Fisheries and Food. The farmer would not be permitted to dispose of the fish, would have to take precautions to prevent the spread of the disease, and would be required to isolate the infected fish until it was determined by an inspector that the fish was not diseased.

The Act also gives authority to inspectors to enter premises and inspect or test the animals for the specific diseases that are listed in the Act or regulations. Diseased animals may be seized, quarantined or destroyed by an inspector. Where listed diseases exist, the inspector also may order the land, water and premises to be cleansed and disinfected. There are no provisions for compensation to be paid under this Act.

The *Animal Disease Control Regulation* requires a veterinarian to report every case of the diseases listed in the Schedule to the Regulation to the Veterinary Laboratory of the Ministry of Agriculture, Fisheries and Food. As noted above, none of the diseases listed in this Schedule are specific to aquatic animals.

The Act provides that the Minister of Agriculture, Fisheries and Food may appoint a veterinarian registered under the provincial *Veterinarian Act* to be the Provincial veterinarian whose duties include administering this Act and the regulations.[153]

At the federal level, the *Health of Animals Act*[154] deals with the control of diseases and toxic substances in animals. Animal is defined to include an embryo and a fertilized egg or ovum. The definition does not exclude fish.[155] The Act requires reporting of the presence of a reportable disease or toxic substance by an owner or veterinarian to a veterinary inspector, who is appointed under this Act. It also contains provisions for segregating animals and prohibits concealing the existence of a reportable disease or toxic substance among animals.

The Act defines reportable disease as one prescribed by regulation. The *Reportable Diseases Regulations*[156] contains the list of diseases that are reportable diseases under the Act. None of the diseases listed are specific to aquatic animals so the provisions of this Act currently are not being applied to cultured fish.

Since neither the provincial or federal legislation lists aquatic diseases as reportable diseases, there is no statutory authority requiring salmon farmers to report fish diseases.

The Memorandum of Understanding Respecting the Fish Disease Database was signed March 28, 1995, on behalf of the Department of Fisheries and Oceans Biological Science Branch and the Ministry of Environment Fisheries Branch, Fish Culture Section. It sets out the responsibility for creating and maintaining the database and for the use of the database. It also addresses the release by the Ministry of Environment, Lands and Parks of information from the Department of Fisheries and Oceans.

Legislation governing pesticides and disinfectants is both federal and provincial.

At the federal level, pesticides and disinfectants are controlled by the Pest Management Regulatory Agency of Health Canada. Products used to control microbial or other pests in the environment of animals, such as products used to deal with net fouling, are regulated as pesticides. Products for the control of external parasites, such as sea lice, administered externally are regulated as pesticides. In contrast, products for the control of external parasites administered through feed or injection are regulated as drugs.[157]

The federal *Pest Control Products Act*[158] establishes the requirements for the registration, packaging and labelling of pest control products in Canada. The Act prohibits the sale or importation of control products unless the product

- has been registered according to regulations under the Act,
- conforms to any other standards set out in the regulations under the Act, and
- is packaged and labelled as required by regulations.

Control products are defined in the Act as products, devices, organisms, substances or things that are manufactured or sold to control, prevent or destroy any pest.[159]

The provincial *Pesticide Control Act*[160] prohibits anyone from applying a pesticide to a body of water or an area of land unless that person has obtained a permit under the Act and applies the pesticide according to the terms of the permit. This general prohibition is subject to exemptions contained in the *Pesticide Control Act Regulation*.[161] A pesticide is defined in the Act as an organism or material that is sold or used to prevent, destroy, repel or mitigate a pest and includes a plant growth regulator, a plant defoliator or plant desiccant and a control product, other than a device, that is defined as a control product in the federal *Pest Control Products Act*.

Fish Feed

Also of concern in connection with the overall health of farmed salmon is the feed used to raise the fish.

At the federal level, the *Feeds Act*[162] provides for the registration and prescription of standards for feed consumed by livestock, which is defined to include fish. The standards permit medicines or drugs to be included in the feeds for animals, birds and fish that are consumed by humans.

The Feeds Regulations[163] include the following:

- the drugs that can be included in fish feeds;
- the animal, fish or bird for which the medicated feed can be prepared;
- the maximum permissible level of drug permitted in the final ration;
- directions for use of the medicated feed;
- cautions regarding the use of the medicated feed and any required warnings; and
- the maximum amount of drug permitted for treatment, preventative or growth stimulating levels.

At the provincial level, Part 8 of the *Pharmacists, Pharmacy Operations and Drug Scheduling Act*[164] addresses the use of medicated feeds. The pharmaceuticals which can be added to feed are listed in a regulation adopted under this Act, the *Veterinary Drug and Medicated Feed Regulation*,[165] in Table 1 of Schedule A to the Regulation. Both the Act and the Regulation are discussed further below.

The *Compendium of Medicating Ingredient Brochures* contain instructions about properly mixing medicated feed. These Brochures are prepared and periodically updated by the Plant Products Division, Agriculture and Agri-Food Canada.[166]

Vaccines

Vaccines are used to prevent disease in farmed fish. The Memorandum of Understanding between the federal and provincial governments provides that vaccines used in aquaculture will be regulated by Agriculture and Agri-Food Canada. The importation of veterinary biologics is governed by provisions in the federal *Health of Animals Act*. Regulations under the Act deal with the manufacture and sale of those products.

Agriculture and Agri-Food Canada also deals with fish biologics such as tissue cultures, pathogen cultures and diagnostic kits based on biologics.

Vaccines are administered by injection prior to placement of the fish into net-cages. This may be followed by revaccination by immersion shortly after placement in the net-cages.[167]

Therapeutic Drugs

If bacterial disease occurs in farmed fish, drugs are often used to attempt to control the outbreak of the disease. The Memorandum of Understanding between the federal and provincial governments provides that therapeutic drugs used in aquaculture will be regulated by Health Canada.

Generally, the use of drugs in the salmon aquaculture industry is regulated similarly to other agricultural sectors. Products for microbial diseases or internal parasites are regulated as drugs. As noted above, products for the control of external parasites, such as sea lice, that are administered through feed or injection also are regulated as drugs.[168]

The sale and the use of drugs, such as antimicrobials, anesthetics and hormones, are regulated by the Bureau of Veterinary Drugs, a division of Health Canada. The federal *Food and Drug Act* authorizes which drugs may be sold in Canada, for what conditions and in which species. It provides the authority for regulations setting specific conditions and standards under which drugs may be prepared for sale. The Act defines a drug as a substance made or sold for the diagnosis, treatment, mitigation or prevention of a disease, disorder or abnormal physical state, or its symptoms, in humans or animals. The Act contains provisions requiring drugs to be labelled and packaged as required by the regulations under the Act.[169]

The Act provides for the appointment of inspectors who have broad powers to inspect, enter premises, and seize items or records in the administration and enforcement of this Act.

The *Food and Drug Regulations*[170] specify requirements for registration and use of various classes of drugs and provide detailed requirements for labelling drugs. The label for a veterinary drug sets out information about the use and administration of the drug that usually includes the following:

- the trade name;
- the generic name;
- the content of the bottle or package;
- the withdrawal time;
- restrictions about the use of the drug;
- the drug registration number;
- storage instructions;
- the species to be treated with the drug and the specific diseases the drug is effective against for each species;
- dosage and feeding directions;
- mixing directions;
- any cautions and warnings about use; and
- the expiry date.

Drug products are licensed with the contents and instructions for administering the drugs listed on the label. Three antimicrobial drugs are licensed for use for salmon. The trade names of these drugs are Terramycin Aqua, Romet and Tribrissen. Each of them is administered in feed. A copy of the labels for each of these is attached in Appendix C.

Only one of the three licensed therapeutants can be used without a veterinary prescription and, in that case, it must be used in the manner stated on the label. Only registered veterinarians are permitted to prescribe the use of the other two therapeutants or deviate from the instructions on a label to a drug. When a veterinarian deviates from the label it is described as off-label or extra-label prescription use.

A veterinarian normally uses a product that is labelled for use for the species and the condition being treated according to the requirements on the label. However, there may be cases where a drug is not available for the species and the specific condition being treated or where the veterinarian is of the view that none of the drugs intended for that species and disease will be effective. In those situations, the veterinarian may prescribe another licensed drug to treat an infection or food animal species not listed on that drug's label. The veterinarian must meet certain requirements, including determining the appropriate withdrawal time for the drug before the species may be slaughtered or a product from it can be used for human consumption.

A veterinarian also may administer a drug for the species listed on the label but write a prescription with a dosage which exceeds the dosage listed on the label if the veterinarian is of the opinion that a higher dose is needed.

The provincial *Pharmacists, Pharmacy Operations and Drug Scheduling Act*[171] permits the use of drugs in the Province and establishes regulations regarding who is licensed to sell them. Part 8 of the Act addresses the use of medicated feeds and veterinary drugs. It defines a veterinary drug as a drug for the treatment, prevention or diagnosis of a disease of an animal,[172] including but not restricted to a drug listed in the regulations adopted under this Act. Medicated feed is animal feed that contains a veterinary drug.

The Act prohibits the manufacture and sale of medicated feeds and the sale of veterinary drugs by anyone other than a prin[illegible], a registered veterinarian or a person holding a licence under this Act. The Act also authorizes the Minister of Agriculture, Fisheries and Food or a person designated by the Minister to prohibit the use of any veterinary drug for veterinary purposes.

The *Veterinary Drug and Medicated Feed Regulation*[173] establishes requirements for issuing and maintaining licences to manufacture and sell medicated feed and to sell veterinary drugs. It does not apply to sales by manufacturers or wholesalers to pharmacists or registered veterinarians. The Regulation specifies four classes of licences: a limited medicated feed licence, a medicated feed licence, a veterinary drug licence, and a veterinary drug dispenser licence. The Regulation also contains provisions regarding storage and dispensing of drugs, as well as requirements for recording purchases and sales.

For example, it requires a holder of a medicated feed licence or a veterinary drug licence to keep a veterinary drug purchase register of all purchases of veterinary drugs made by the licence holder. The licence holder is required to forward the veterinary drug purchase register to the provincial veterinarian once each year covering all the purchases during the year of the register. Where veterinary drugs are mixed in medicated feed on the written order of a veterinarian, the licence holder also must forward those orders to the provincial veterinarian annually with the veterinary drug purchase register.[174]

The *Veterinary Drug and Medicated Feed Regulation* allows a medicated feed licence holder

- without the order of a registered veterinarian, to manufacture and sell medicated feeds containing any of the veterinary drugs listed in Table 1 of Schedule A to the Regulation, if the strength does not exceed that authorized under the federal *Feeds Act*, and
- only on the written order of a registered veterinarian, to manufacture and sell medicated feeds containing

- any of the veterinary drugs listed in Table 1 of Schedule A to the Regulation in strengths exceeding those authorized under the federal *Feeds Act*, or
- other veterinary drugs not listed in Table 1 of Schedule A to the Regulation.

The *Veterinary Drug and Medicated Feed Regulation* also lists who can hold a veterinary drug licence and authorizes a licence holder to sell the veterinary drugs which are listed in Table 2 of Schedule A to the Regulation. Licences may be limited to certain products.

The *Compendium of Medicating Ingredient Brochures* lists veterinary drugs that may be used without a prescription and under what requirements that use may occur, including dosage, species and disease. For each drug it indicates the species and condition to be treated, the level that may be added to feed without a prescription, drugs with which it may not be compatible, mixing instructions and withdrawal times. An example of a drug listed in the *Compendium of Medicating Ingredient Brochures* that is licensed for use for salmon is Terramycin-Aqua in which the active ingredient is oxytetracycline hydrochloride.

Hormones, such as testosterone and its derivatives, which normally are used only on broodstock, are controlled drugs and regulated in accordance with those drugs listed in Schedule G of the *Food and Drug Act*.

The provincial *Aquaculture Regulation* requires salmon farmers to keep a record of drugs administered to farmed salmon, including the following information:

- the aquaculture licence number and name of the licence holder;
- the location of the salmon farm;
- the species of finfish being cultivated;
- the name of the veterinarian who prescribed any drugs; and
- a log of the drugs, procedures for administering the drug, the treatment schedule with the date treatment was started, the date of the last treatment and the name and signature of the person responsible for administering the treatment.[175]

The *Aquaculture Regulation* further provides that a person delivering finfish from an aquaculture facility to a processing plant or fish buying station will provide a statement[176] that includes, among other things, the date of the last treatment, if any, with a drug including

- the name of the drug,
- the treatment schedule,
- the dates treatment started and finished,
- the name of the veterinarian, if any, who prescribed any drug, and
- the name and signature of the person responsible for administering the treatment.[177]

Also according to the *Aquaculture Regulation*, there must be a drug free period of 105 days before harvest after a licence holder administers a drug to farmed salmon, unless

- the federal *Food and Drugs Act*[178] or its regulations provide standards governing the use of the drug and the holder has followed those standards, or
- the drug is prescribed by a veterinarian, the veterinarian has prescribed a mandatory minimum withdrawal period and the holder has complied with all the veterinarian's instructions.[179]

A list of substances reported to be used on fish farms in 1995/96 which was provided by B.C. Environment (MELP) is attached as Appendix D. This list of substances includes both product names and active ingredients. In that regard, the following should be noted:

- Terramycin Aqua is a product name for oxytetracycline;
- Gallimycin 200 is a product name for erythromycin;
- Aquaflor is a brand of florfenicol;
- Mult-vacc 3 is a vaccine;
- TMS 222 is a product name for tricaine methane sulfonate;
- Idophor is also known as ovadine or aurueyne.[180]

Residues

The Memorandum of Understanding between the federal and provincial governments provides that the federal government will monitor aquaculture products destined for human consumption for antibiotic residues, toxic materials and other additives or contaminants. Therefore, farmed salmon ready for market are subject to testing for unacceptable residues of these substances. Up until recently this was done by the Inspection Branch of the Department of Fisheries and Oceans but is now a responsibility of the newly created Canadian Food Inspection Agency.

The federal *Fish Inspection Act*[181] governs the inspection of farmed fish for export. It sets out the federal role in ensuring that fish and seafood meet strict national quality standards from the time they leave the water to when they are distributed to the marketplace for export or interprovincial trade. The Act gives inspectors powers to enter premises and inspect products. The Act prohibits the import, export or possession for export of tainted, decomposed or unwholesome fish. The Minister is authorized to decide appeals from the decisions of inspectors.

The federal *Fish Inspection Regulations* set out the requirements for inspections at fish plants.[182] These Regulations require that all fish for export must be processed in an establishment where a prescribed quality management program is in place. Fish are inspected upon arrival at the establishment according to procedures set out in the quality management program. Inspection records must be kept for review. These facilities are subject to inspection through audits to determine compliance with the quality management plan.

Up until recently, the Department of Fisheries and Oceans randomly tested samples of farmed salmon for the presence of the antimicrobial compounds approved under the *Food and Drugs Act* for use on salmon. It also conducted tests for pesticide residues and heavy metals, but did not necessarily test for other drugs that may be prescribed by a veterinarian. The Health Protection Branch of Health Canada, in conjunction with the Department of Fisheries and Oceans, conducted special investigations of residues under the *Food and Drugs Act*, including drugs not covered by the routine monitoring of the Department of Fisheries and Oceans.

This testing of farmed salmon for the presence of residues will now be conducted by the newly created Canadian Food Inspection Agency. The regularity of drug residue testing is dependent on the performance rating of the facility. It was estimated that the Department of Fisheries and Oceans conducted approximately 200 samples per year. Results of the testing were considered confidential by the Department of Fisheries and Oceans.[183]

If fish were found to contain unacceptable drug residues, test results would be forwarded to the provincial fish inspection section and to the processor and efforts made to halt the sale of the product.

The provincial *Fish Inspection Act*[184] also regulates operations in the fish processing industry. The *Fish Inspection Regulation*[185] sets requirements for fish processed and sold within British Columbia. The Act prohibits anyone from selling fish intended for human consumption that is tainted, decomposed or unwholesome.

This Act establishes the basis for appointing inspectors who are authorized to enter premises, boats or vehicles and to take samples of fish required for inspection. If an inspector believes, on reasonable grounds, that an offence under this Act or regulations has been committed, the inspector may seize all fish and containers related to the offence. If someone is convicted of an offence under this Act, in addition to any other penalty

imposed, the fish and containers that have been seized are forfeited to the Crown and may be disposed of under the Minister's direction with the proceeds going into the consolidated revenue fund.

Inspectors under the *Fish Inspection Act* (Canada) and fishery officers under the *Fisheries Act* (Canada) are inspectors under this Act.

As noted above, the *Aquaculture Regulation* provides that a person delivering fin fish from an aquaculture facility to a processing plant or fish buying station will provide a statement about drugs administered to the fish being delivered. As is the case for aquaculture facilities, processing plants and fish buying stations are licensed under Part 3 of the provincial *Fisheries Act.* Since the Act contains broad powers for the minister to require licence holders to submit reports in a manner and at times specified by the minister,[186] the minister could require a processing plant or fish buying station to report on any drugs administered to farmed fish which were delivered to that facility.

VIII. SALMON FARM WASTE DISCHARGE

A. Provincial Regulatory Requirements

A number of waste materials are released into the environment from salmon farms. The discharge of waste has given rise to concerns about impacts to the receiving environment, including sediments and the benthic community.[187]

The provincial *Waste Management Act*[188] and the Aquaculture Waste Control Regulation[189] set out requirements governing waste discharged from salmon farms. The Act and Regulation are administered by the Ministry of Environment, Lands and Parks.

In general, the *Waste Management Act* prohibits the introduction of waste into the environment, unless in compliance with a valid permit. The *Aquaculture Waste Control Regulation* creates an exemption from the general requirement for a salmon farm to obtain a permit under the Act where a number of conditions set out in the Regulation are met. It is not necessary to apply for an exemption under the Regulation. Rather, the exemption automatically applies where

- the total feed usage of the salmon farm does not exceed 630 tonnes of dry weight per year,
- the use, storage and disposal of materials and wastes on or off the site of the salmon farm is carried out in a way that minimizes odour, risk of spillage and impact on wildlife,
- there is a monitoring program allowing a determination of environmental impacts,
- the salmon farmer notifies the Regional Waste Manager of changes in the operation that alter the discharge of waste,
- the salmon farmer reports pollution caused by the operation and takes steps to prevent the recurrence of pollution,
- there is an approved contingency plan for procedures to be followed in the event of a major fish kill, including the disposal of fish mortalities, and
- specific criteria for the discharge of treated domestic sewage are met.

Concerns have been expressed that, since no application for an exemption is required, the Ministry of Environment, Lands and Parks may not always be aware that a salmon farm is operational. Information about the requirements of the Regulation may, therefore, not be communicated to the salmon farm operation. Also, if a farm increases in size and its feed consumption exceeds 630 tonnes per year, the ministry may not be aware of this change and, therefore, not require the farm to apply for a waste management permit.

Salmon farms that do consume more than 630 tonnes of feed per year require a waste management permit issued under the *Waste Management Act*. This permit sets out specific conditions governing the discharge of waste from the salmon farm for which it is issued. These include some or all of the following types of provisions:

- details of the characteristics of the effluent permitted to be discharged;
- particulars of permitted discharge of finfish feed and faeces;
- a description of the location of the facilities;
- requirements for maintaining the pollution control works, as well as emergency procedures;
- requirements regarding outfalls;
- notations that additional works may be required to deal with problems such as wildlife being attracted to the site;
- requirements for disposal of solid waste and dead fish;
- monitoring requirements;
- sampling and analytical procedures;
- reporting;
- contingency planning.

Currently, eleven farms in B.C. possess waste management permits, with permitted feed usage ranging from 750 tonnes per year to 1,180 tonnes per year.[190] A list of the farms with permits is attached as Appendix E.

When a salmon farm operator applies for a waste management permit, the Ministry of Environment, Lands and Parks must comply with the regulatory requirements regarding notice to the public and a public comment period. If a waste management permit is issued to a salmon farm and the applicant or any other party considers itself aggrieved by the decision to issue the permit or by any of the specific provisions in the permit, that person may appeal the decision according to the procedures set out in the *Waste Management Act*.[191]

The *Waste Management Permit Fees Regulation*[192] authorizes the collection of fees for discharging contaminants under a waste management permit. There is a fee payable when someone applies for a permit or an amendment to a permit. There is also an annual fee payable for each permit held. The amount of the fee is based on the types of contaminant discharged and the maximum quantity of those contaminants authorized by the permit. The annual permit fee for salmon farms possessing waste management permits ranges between approximately $800.00 and $1,100.00. Salmon farms that do not have a permit are charged an annual base fee of $100.00.

The provincial Land-Based Fin Fish Waste Control Regulation[193] provides that an owner of a land-based finfish facility may be exempted from the general requirement to obtain a waste management permit under the Waste Management Act if the conditions of the Regulation are satisfied. An owner must register under the Regulation to qualify for the exemption. The Regulation contains standards for the quality of effluent discharged from the facility into the environment.

In 1990, the provincial Ministry of Environment produced a document titled Environmental Management of Marine Fish Farms[194] summarizing the environmental practices and regulatory

procedures required for marine finfish netcage aquaculture operations on the B.C. coast. It explains a number of the provisions of the Waste Management Act and regulations adopted under it and provides details about the reporting and monitoring requirements. Copies of this document were sent to all finfish farm operators.

B. Dead Fish Disposal

All salmon farms are required to report quarterly on the method of disposing of dead fish originating from the farm site as part of the environmental monitoring program for marine fish farms.[195] Further, if the farm employs a collection or disposal service for off site disposal, the farm is asked to provide the contractor's name. If off site disposal is done by farm staff, the farm is required to indicate the location and method of disposal.

C. Federal Regulatory Provisions

At the federal level, the *Fisheries Act*[196] prohibits the deposit of deleterious substances in any water frequented by fish or in any other place where it may enter water frequented by fish. The term deleterious frequently has been interpreted to mean harmful or toxic substances. If a salmon farm were to discharge waste materials that were found to be deleterious in waters frequented by wild stocks, it could be subject to a prosecution under the federal *Fisheries Act*.

The Act also provides the authority to make regulations prescribing deleterious substances and authorizing the deposit of maximum quantities or concentrations of these substances. For example, regulations governing the discharge of effluent from pulp and paper mills and mining operations have been adopted under this authority. There are no *Fisheries Act* effluent regulations for the aquaculture industry.

The provision of the Act prohibiting the deposit of deleterious substances remains substantially unaltered in the proposed new federal *Fisheries Act* and will not be an area that is subject to delegation to the province.[197]

IX. MARINE MAMMALS AND OTHER SPECIES

The methods that salmon farmers use to attempt to prevent marine mammals and other species from preying on farmed salmon are governed by both federal and provincial legislation.[198]

The *Marine Mammal Regulations,* adopted under the federal *Fisheries Act,* prohibit anyone from disturbing a marine mammal except when fishing under the authority of these Regulations. They further provide that any attempt to kill a marine mammal must be made in a manner that is designed to kill it quickly. Anyone fishing for a marine mammal must have the equipment necessary to retrieve it and anyone who kills or wounds a marine mammal must make a reasonable effort to retrieve it immediately.[199]

Seals and sea lions are protected under the authority of the federal Fisheries Act. If seals and sea lions cause the loss of fish or equipment, they can be killed only with a fishing licence issued under the authority of sections of the *Marine Mammal Regulations*[200] and the *Fishery (General) Regulations*.[201] These licences are issued subject to a number of terms and conditions. A typical licence includes the following conditions:

- only harbour seals, California Sea Lions and Steller Sea Lions may be killed;
- only seals and sea lions that are actually taking or attempting to take fish in seas cages may be killed;
- the area of killing is the immediate site of the sea cages and killing must not occur outside the boundaries of the lease or licence of occupation for the farm;
- employees who kill seals or sea lions must meet one of the following qualifications:
  - certification from the Conservation and Outdoor Recreation Education Program;
  - completion of a basic firearm safety course; or
  - possession of a provincial hunting licence;[202]
- firearms used must meet certain specifications;
- every attempt must be made to retrieve seals and sea lions killed for biological sampling; and
- the licence holder must submit quarterly reports listing the number of harbour seals killed, the number and species of sea lions killed, and the date each animal was killed.

A sample licence is attached as Appendix F.

At the time of the initial application for a licence, the applicant must satisfy the Department of Fisheries and Oceans that it has taken other measures to attempt to deal with problems with seals and sea lions before a licence to kill them will be issued. When the licence is issued, the Department of Fisheries and Oceans notifies the R.C.M.P., the provincial conservation officer and the federal fisheries officer. A licence is issued for a period of one year and will be renewed if the licence holder complies with the terms and conditions set out in the licence, in particular, the submission of quarterly reports on marine mammals killed.

This is a self-reporting system and the Department of Fisheries and Oceans has no formal auditing system in place. There have been no prosecutions for violations of these licences by salmon aqua-culture operators. At present, most operating farms possess a valid licence to kill seals and sea lions.[203]

The *Migratory Bird Convention Act*[204] implements a convention for the protection of migratory birds in Canada and the United States. It provides a number of protective measures for a wide range of birds, including some of the species that have been found to interact with farmed salmon in net cages, such as waterfowl, gulls and herons. Under regulations adopted under the Act, the convention allows permits to be issued to kill listed species that are seriously injurious to agricultural or other interests in a community.

Small mammals such as river otter and mink are protected under the provincial *Wildlife Act.* A salmon farmer must have a permit to trap or kill these species if trapping or killing the species would occur out of season. If the permit is for trapping and relocating the species, staff of the Ministry of Environment, Lands and Parks will refer the salmon farmer to a licensed trapper. A permit to trap or kill a species is issued under section 19 of the *Wildlife Act* and must comply with any additional requirements authorized by regulations under the Act. The permit may be issued by the regional manager of the recreational fisheries and wildlife program or a

person authorized by the regional manager. It usually is issued by a district conservation officer. The permit may exempt the salmon farmer from the requirements of section 9 of the *Firearm Act*[205] which prohibits discharging or carrying a firearm containing live ammunition in or on a motor vehicle or other conveyance without a permit issued by the chief provincial firearms officer.

Any employee of a salmon farm who uses a firearm belonging to the salmon farm must obtain a valid firearms acquisition certificate issued under the federal *Criminal Code*. Also, the provincial *Wildlife Act* requires that anyone carrying a firearm must hold either a hunting licence or a firearm licence.

The provincial *Firearm Act* provides that anyone with a firearm in his or her possession or under his or her control must exercise care for the safety of other persons or property.[206]

The aquaculture operating licence issued under the provincial *Fisheries Act* by the Ministry of Agriculture, Fisheries and Food requires a salmon farmer to undertake reasonable and lawful practices necessary to prevent marine mammals and birds from preying on farm fish. Illegal shooting or snaring of furbearers or birds is not considered acceptable practice.[207]

At some salmon farms acoustic deterrent devices are used as another method to deter marine mammals from preying on farmed salmon. The federal Department of Fisheries and Oceans issues authorizations for farms to deploy and operate acoustic deterrent devices according to specific procedures and requirements. An example of a letter authorizing the use of acoustic deterrent devices is attached as Appendix G.

Concerns have been expressed regarding the use of artificial lights. The *Pacific Fisheries Regulations*[208] prohibit the use of torches or artificial lights to attract or repel fish other than squid and the use of fishing gear with a flashing light attached to it. This prohibition is not applied to lights used for other purposes.

X. EMERGENCIES

In the event of an environmental emergency occurring in connection with a salmon farm, the provincial Minister of Environment, Lands and Parks could use the powers set out in the *Environment Management Act*[209] to deal with the situation.

XI. MONITORING

A. The Purpose of Monitoring

Monitoring of salmon farms can be undertaken for a variety of purposes, including to

- ensure that salmon aquaculture activities and practices comply with prescribed standards,
- determine whether the regulatory standards are appropriate for the intended objectives, such as protection of the environment, and
- improve the basis for understanding the mechanisms that cause changes or impacts in the ecosystem in which a salmon farm operates.[210]

B. Compliance Monitoring

The Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks monitors compliance with tenure requirements. Regional staff will examine a salmon farm site by air to ensure diligent use, that the farm is in the correct location, and that the farm conforms with its approved Aquaculture Development Plan for layout and the numbers of net-cages. To confirm the actual use of the site, photographs of the site are placed in the file for the salmon farm. While staff attempt to inspect each site on an annual basis, due to budget constraints some sites are inspected only every two to three years.

The Aquaculture and Commercial Fisheries Branch of the Ministry of Agriculture, Fisheries and Food monitors compliance with the terms of the aquaculture licence issued to a salmon farm under the provincial *Fisheries Act*. Inspectors from this ministry are responsible for enforcement of all provisions of the *Aquaculture Regulation* and the terms and conditions of each aquaculture licence issued.

Inspectors from the Ministry of Agriculture, Fisheries and Food visit each salmon farm generally twice a year to check that the species raised, the number of cages, the number of fish and other licence conditions comply with the aquaculture licence issued to that farm. During the site visit they also review records of drug use and mortality disposal. Any concerns regarding fish health or the suitability of the site are brought to the attention of the finfish biologist, the provincial fish health veterinarian or another appropriate government agency.

The Ministry of Agriculture, Fisheries and Food also conducts a fish health monitoring program. The provincial fish health veterinarian and the finfish biologist visit each salmon farm for this purpose at least once a year.

Due to the lack of human and financial resources within the Ministry of Environment, Lands and Parks, inspection of salmon farms and monitoring for compliance with waste discharge permits issued under the *Waste Management Act* occurs only on a periodic basis, as infrequently as once per year. There is no regular schedule for inspections and compliance monitoring of salmon farms

which are exempted under the *Aquaculture Waste Control Regulation* from obtaining a waste management permit. In these cases compliance monitoring occurs even less frequently than on sites that do have a permit and may not take place even once per year.

If a salmon farm was found to be in significant noncompliance with its waste management permit or with the requirements of the *Aquaculture Waste Control Regulation,* the farm could be listed on the Environmental Protection Noncompliance Report. This Report is released by the province every six months identifying operations whose compliance record during the reporting period was of concern to the Ministry of Environment, Lands and Parks. The operations included in this Report are those authorized by waste management permits, regulations and other instruments.

C. Environmental Effects Monitoring

In 1988, the Ministry of Environment developed an environmental monitoring program for marine fish farms.[211] Three levels of mandatory monitoring were established based on the annual feed used by each farm. Each category triggered different monitoring requirements. Farms using larger quantities of feed required more

extensive monitoring on the assumption that water quality and benthic impacts are directly related to the amount of feed used by the farms.[212] The three levels that corresponded to different monitoring requirements were

Schedule A: using less than 120 tonnes of feed annually, Schedule B: using between 120 and 630 tonnes of feed annually, and Schedule C: using over 630 tonnes of feed annually.

The latter category of facility would require a permit issued under the *Waste Management Act.* A typical permit[213] would include a provision that the permit holder must monitor the receiving environment and maintain materials accounting, fish production, waste handling records and other requirements as described by Schedule C in the *Environmental Monitoring Program for Marine Fish Farms*. A facility operating under the first or second category would be exempt from the requirement to obtain a permit, provided it met the other requirements set out in the *Aquaculture Waste Control Regulation* as listed above.

The Ministry of Environment, Lands and Parks receives environmental monitoring program information from fish farms on a form called a Dataform I. The information is submitted to the Ministry on a quarterly basis. Listed on the form is the feed type and quantity used, other materials used, such as antibiotics, anaesthetics, and disinfectants, details about mortality disposal and

D. Residue Monitoring

As noted above, the Memorandum of Understanding between the federal and provincial governments provides that the federal government will monitor aquaculture products for antibiotic residues, toxic materials and other additives or contaminants if the products are for human consumption. Therefore, farmed salmon ready for market are subject to testing by the Canadian Food Inspection Agency for unacceptable residues of these substances.

XII. REPORTING INFORMATION

Salmon farm operations are required to report a variety of different types of information to various government agencies, including information on

- escaped fish,
- use of therapeutics,
- killing of marine mammals,
- environmental and other monitoring, and
- production.

For example, the Ministry of Agriculture, Fisheries and Food requires aquaculture producers to provide annual aquaculture statistical reports which indicate the amount of fish stocked, the amount of fish harvested and sales by species during the annual reporting period. The ministry also requires fish processors to provide cultured finfish quarterly reports which indicate the amount of fish processed during the quarterly reporting period as well as the locations from which the fish were delivered for processing.

While some information is shared between government agencies, there are only a limited number of publications to routinely report data to the public without a request. For example, the annual British Columbia Seafood Industry Year in Review218 provides aggregate information about farmed salmon production and employment.

In addition, some information which is reported to government agencies is available on request. Other information is considered by some government agencies to be confidential business information and not available to the public.

Information held by government agencies is subject, at the federal level, to the provisions of the Access to Information Act.219 Information held by provincial agencies is subject to the Freedom of Information and Protection of Privacy Act.220 Both the federal and provincial Acts have a general right of public access to government information, followed by exceptions to those rights of access. Each Act has an exception based on protecting business or commercial interests. If a request for information was made to a government agency, it would not be released if it fit within one of the exceptions, which would depend on whether it met the specific requirements in the relevant Act. As well, both the federal and the provincial Acts have a provision allowing an exception to be overridden if the release of the information is determined to be in the public interest.

XIII. PENALTIES and ENFORCEMENT

The legislation governing salmon farming incorporates a variety of penalties for violations and several mechanisms for enforcing statutory provisions.

If a salmon farm is not complying with the terms of its tenure, the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks notifies the holder of the licence or lease and identifies the conditions that must be rectified. Where the conditions of tenure are not met, the tenure may be cancelled.

According to the B.C. Lands Aquaculture Policy, a performance and clean-up guarantee is required as a condition of issuing a lease or licence of occupation under the Land Act to operate a salmon farm. A minimum guarantee of $1,000 is required for each tenure. However, the Ministry of Environment, Lands and Parks has the discretion to increase that amount depending on the local site conditions, the location of the site and the nature of the improvements.

It is also possible under the Aquaculture Policy for a blanket guarantee to be arranged where several tenures are held by one party or by an aquaculture association on behalf of its members.

A salmon aquaculture licence issued under the provincial Fisheries Act may be suspended or revoked by the Minister if the holder violates a provision in Part 3 of the Fisheries Act, the regulations or a condition of the licence. This is in addition to all other available penalties. Before suspending or revoking the licence, the Minister must conduct an investigation and hold a hearing if requested to do so by the licence holder. The Minister must preside at the hearing and has the same powers as the Supreme Court regarding witnesses and evidence.221 In addition, where a licence has been revoked or there has been a violation of a provision in Part 3 of the Act, the regulations or a condition of the licence, the Minister may subsequently refuse to issue a licence under this Act to that licence holder, in addition to all other available penalties.222

The penalty under the provincial Fisheries Act for operating a salmon farm without an aquaculture licence is a fine of not less than $500 and not more than $10,000. The maximum fine for other violations of Part 3 of the provincial Fisheries Act, the Aquaculture Regulation or a condition of an aquaculture licence is $2,000. Also, the Act allows for the possibility that farmed fish could be seized by a provincial constable or an inspector of fisheries after an offence has occurred.223

Violations of the provincial Waste Management Act and regulations adopted under it can be enforced by prosecution. Fines under the Act and regulations vary according to the type of violation, up to a maximum of $1,000,000.224 The Act also contains provisions authorizing pollution abatement orders and pollution prevention orders. There have been few, if any, prosecutions of salmon farms under the Act. The limited resources dedicated to monitoring compliance with the Waste Management Act make it difficult to assess whether the lack of charges and prosecutions indicates a high level of regulatory compliance throughout the industry or inadequate monitoring by regulators.

If a salmon farm were charged or prosecuted, it would be listed on the Environmental Charges and Penalties Report. This Report is released by the province every six months outlining the charges, convictions and penalties imposed under environmental legislation including the Waste Management Act, the Water Act, the Pesticide Control Act and environmental provisions of the federal Fisheries Act.

Violations under the provincial Heritage Conservation Act are subject to penalties including fines of up to $50,000 for an individual and up to $1,000,000 for a corporation.

Violations of the federal Fisheries Act resulting in the destruction or alteration of fish habitat or for depositing deleterious substances in waters frequented by fish can be enforced by prosecution. The maximum fines in respect of these provisions range from $200,000 for a first offence to $1,000,000 or three years' imprisonment

or both for subsequent offences. There have not been any charges laid or prosecutions against salmon aquaculture operations for violations of these provisions of the Fisheries Act.225

XIV. ENVIRONMENTAL ASSESSMENT

A. Federal Environmental Assessment

A federal environmental assessment is required under the Canadian Environmental Assessment Act226 if a federal authority, as defined in that Act, exercises one or more of the following duties, powers or functions in relation to a project:

- proposes the project;
- contributes any other form of financial assistance to the project;
- sells, leases or otherwise transfers control or administration of land to enable the project to be carried out; or
- exercises a regulatory duty in relation to a project, such as issuing a permit or licence, that is included in the Act's Law List regulation.

A project is defined as either an undertaking in relation to a physical work or any physical activity not relating to a physical work that is listed in the Act's Inclusion List regulation.

Any salmon farm that requires approval under paragraph 5(1)(a) of the Navigable Waters Protection Act will be considered to be a project for the purposes of the Canadian Environmental Assessment Act and the request for an approval will trigger at least a screening by the Department of Fisheries and Oceans for potential environmental effects. This provision of the Act states that no work is to be built or placed in, on, over, under, through or across any navigable water unless the work, the site and the plans have been approved by the Minister of Fisheries and Oceans prior to commencement of construction.227 The approval process required under paragraph 5(1)(a) of the Navigable Waters Protection Act is the exercise of a regulatory duty.

A number of provisions from the existing federal Fisheries Act are included in the Canadian Environmental Assessment Act's Law List regulation and, therefore, also trigger the requirement for a federal environmental assessment. Provisions of the Fisheries Act that could relate to salmon farm operations include the following: subsection 35(2): issuing an authorization for the harmful alteration, damage or destruction of fish habitat; and subsection 37(2): ordering modifications or restrictions to works to prevent destruction of fish habitat.

None of the provisions of the federal Fisheries Act has triggered a federal environmental assessment of a salmon farm to date.

B. Provincial Environmental Assessment

The possible application of the provincial Environmental Assessment Act228 to salmon farming activities will be considered following the Salmon Aquaculture Review being conducted by the Environmental Assessment Office. It will be necessary to determine if the provisions of the Act will apply to new and expanding salmon aquaculture operations and, if so, whether all farms will be subject to review or only those that exceed a particular threshold size.

The provincial Environmental Assessment Act, brought into force in 1994, provides for the integrated assessment of reviewable projects to ensure that plans for prospective projects will prevent or reduce adverse effects of proposals during design, construction, operation, modification, and closure.

The purpose section provides that the Act should:

- promote sustainability,• provide for a thorough and integrated assessment of the environmental, economic, social, cultural, heritage and health effects of projects,• prevent or mitigate adverse effects,• provide an open review process,• provide for public participation.

For this Act to apply to a proposed project, it must be determined to be a reviewable project under the Act. The Environmental Assessment Reviewable Projects Regulation specifies which projects and activities are subject to the Act by defining the type and size of projects and activities which require review under the Act. In addition, if the proposed project is not included in the Regulation, the Minister of Environment, Lands and Parks may designate a project as a reviewable project229 if she or he is satisfied that

(a) the project has or may have a significant adverse effect, and

(b) the designation is in the public interest.

If the Act applies, a reviewable project may undergo one, two or three stages in the review process: the Application phase, the Project Report phase and the Public Hearing phase. Not all projects proceed through each of these phases.

If a project proceeds to the second phase, the Project Report stage, section 22 of the Act provides a list of issues that may be required to be addressed in a project report, including but not limited to issues such as

- why the site was chosen and a description of alternative sites considered,• the existing environmental and other characteristics that may be affected,• the potential for direct and indirect effects,• potential impacts on the exercise of aboriginal rights,• health issues,• the potential for accidents with adverse effects, and• data to assess the probable cumulative effects.

At the conclusion of each phase of the review, the project may be approved, rejected or sent for further review until the final phase is completed and the project is either approved or rejected.

A project committee, comprising representatives of various government agencies and First Nations, provides advice, analyses and recommendations on projects throughout the review process.

It is also possible for a public advisory committee to be established under the Act to advise and make recommendations to the project committee on matters of public concern.

Every application, comment, report and decision in the review process must be filed in the project registry in the Environmental Assessment Office in Victoria, including any decisions made by the Ministers or Cabinet. The project registry provides the public with access to all relevant project documents. Key documents from the

registry will also be available in locations such as government offices or public libraries in communities that may be affected by specific projects.

Throughout the review process the public has guaranteed opportunities for comment within timeframes set in a regulation. Specifically, the Act requires the executive director to provide notice to the public, inviting comments, at the following points in the process:

- upon receipt of an application;• when the draft project report specifications are being prepared;• upon receipt of the project report; and•when the draft terms of reference for a public hearing is being prepared.

The Act also establishes a role for the Environmental Assessment Office in public consultation. It requires the executive director to assess the applicant's plans for distributing information, allows the Office to carry out certain functions itself, and authorizes the Environmental Assessment Office to carry out or oversee the public consultation if the applicant's efforts are not satisfactory.

At the option of the proponent, review of applications for permit and licences required under other statutes may occur concurrently with the application for a project approval certificate.

The Act also allows for category assessments so a whole category of reviewable projects could be reviewed and specifications developed that would be used in the individual assessments of projects. Proponents would be required to include these specifications and provide information required for the entire category in applications for review of a particular project.

XV. MORATORIUM DURING ACTION PLAN

In April, 1995, the province announced the Action Plan for Salmon Aquaculture. The Action Plan includes a review of provincial finfish aquaculture policy and the environmental review, under the Environmental Assessment Act, of salmon aquaculture issues.

The Action Plan also triggered the suspension of approvals of new salmon farms for the duration of the policy review and the environmental assessment. Further, it set up an interagency review process to screen applications for replacements and amendments to existing salmon farms, involving the Regional Fish Farm Review Committee in each of the coastal regions of the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks.230

In 1996, the province extended the time of the moratorium on new tenure decisions and made additions to the terms of reference of the Regional Fish Farm Review Committee, as noted below.231

While no decisions will be made during this period approving or rejecting applications for new tenures, applications are being accepted and held by the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks. Applications are not processed beyond checking the status of the area.232 A list of pending applications for new tenures on file at the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks as of October, 1996, is attached as Appendix I.

During this period, salmon aquaculture tenure holders may apply to replace their existing tenures or apply for administrative amendments to existing tenures and aquaculture licences. Administrative amendments are defined as follows:

- minor boundary changes;
- increases to production on existing sites and area expansion under exceptional circumstances only;
- exchanging or cancelling an existing site where there are exceptional environmental or operational concerns and the exchange or cancellation cannot be postponed until completion of the fish farm review;
- pen number and size changes; and
- species change.

During the period of the provincial aquaculture review, all applications for replacement or amendment of existing tenures must be referred to a Regional Fish Farm Review Committee for consideration.233 Each Committee is chaired by a representative of the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks and has members representing the following organizations:

- Ministry of Environment, Lands and Parks, Environmental Protection Program;
- Ministry of Environment, Lands and Parks, Fisheries Program;
- Ministry of Agriculture, Fisheries and Food, Licensing, Inspection and Field Services Section;
- Ministry of Small Business, Tourism and Culture;
- Department of Fisheries and Oceans; and
- Environment Canada, Environmental Protection Service.

The role of the Committee is to review and make recommendations to the appropriate agency on applications for replacements and administrative amendments to existing sites and for amendments to aquaculture licences arising from changes in species or in production capacity. Final decisions rest with the approving agencies. The Committee scrutinizes applications to determine possible environmental impacts. It can require applicants to submit studies that could include biophysical assessments, environmental impact assessments, and studies reporting on possible impacts on local government, First Nations, sport or commercial fisheries. The work of the Committee may involve consultation with industry.

In the 1996 Directive the existing terms of reference for the Regional Fish Farm Review Committee were confirmed and expanded to include the following:

- consideration of First Nation infringement issues;
- access to the executive of the Ministry of Environment, Lands and Parks and the Ministry of Agriculture, Fisheries and Food for guidance when

required; and• consideration of production increases on a site by site basis, but only on those sites where the increase is environmentally sustainable.

The 1996 Directive also confirmed that the existing Regional Fish Farm Review Committee for the Vancouver Island Region meets the needs of the three regions involved in aquaculture.

XVI. MANAGEMENT AND REGULATORY ISSUES

A number of management and regulatory issues have emerged during the review of the current regulatory framework for salmon aquaculture. Some of the issues have been identified through discussions with various parties in connection with the preparation of this paper. Other issues have been identified during the meetings of the Salmon Aquaculture Review Committee. Additional issues may be identified by members of the Technical Advisory Team in the course of reporting on their work.

The issues and concerns about the management and regulatory framework that have been raised include the following (this is not an exhaustive list and does not contain all of the issues raised during the review which are being tracked by the Environmental Assessment Office):

- The level of coordination and cooperation among government agencies involved in the regulation of salmon aquaculture, including the Ministries of Environment, Lands and Parks and Agriculture, Fisheries and Food.
- The perceived complexity of the regulatory framework.
- The desire for a coordinated or single window approach for salmon farmers or other interested members of the public to access the regulatory framework.
- The length of time it takes to receive all necessary approvals prior to beginning to operate a salmon farm.
- The length of time it takes to process tenure renewal or amendment applications.
- The desire for security of tenure.
- The potential benefits of receiving the waste management permit application at the same time as an application for land tenure rather than having the waste management permit application process operate as a process separate from the approval process for tenure.
- The degree of scrutiny given to the information submitted to government agencies in support of applications for tenure or for operating licences.
- The need for coordination and accountability for decisions during the siting process.
- The lack of a complete referral process at the time replacement tenure is considered.
- Whether First Nations receive referrals when the Environment and Lands Regions Division of the Ministry of Environment, Lands and Parks is considering issuing a replacement tenure for an existing salmon farm.
- Whether requirements contained in guidelines and policies should be the subject of enforceable regulatory standards.
- Whether guidelines are being followed, in part due to lack of resources.
- Whether regulations are being enforced, in part due to lack of resources.

- The possibility of raising revenue through the regulatory system to provide resources for improved monitoring and enforcement of existing standards.
- The possibility of a regulatory mechanism that requires the protection of ecosystem health or the overall protection of ecological integrity.
- Whether current regulations and guidelines would be adequate to protect the environment if the industry were to expand significantly.
- The lack of a mechanism for triggering a regulatory response if an impact is detected through analysis of monitoring data.
- The consideration of mandatory measures to prevent environmental problems, such as requirements for fallowing sites.
- The system of regulating waste discharge differently for classes of farms using different amounts of feed.
- The lack of resources available for monitoring and enforcement by the Ministry of Environment, Lands and Parks, a situation which may become more serious following recent provincial budget cuts.
- Public access to information regarding issues such as • presence and type of disease, • use of therapeutics and other chemicals, • transport of fish, • monitoring data, • compliance reporting, and • escapes of farmed fish.
- The possible labelling of farmed salmon products.
- The opportunities to formalize public input in decision-making at various stages of the approval process and for certain ongoing operating matters.
- The need to clarify and improve opportunities for local government involvement.
- The possibility of developing additional dispute resolution mechanisms.
- The adequacy of provisions to deal with noise.
- A consideration of mandatory requirements for training or certification of staff on salmon farms.

These and other issues may be assessed and considered in the development of options to address possible changes to the management and regulatory framework.

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Appendix A—ICUN resolution

Appendix B—Sample Aquaculture Licence

Appendix C—Labels for Three Antimicrobial Drugs

Appendix D—List of Reported Substances

Appendix E—Salmon Farms with Waste Management Permits

Appendix F—Sample Licence to Kill Marine Mammals

Appendix G—Sample Authorization for Use of Acoustic Deterrent Device

Appendix H—Dataform I

Appendix I—List of Pending Salmon Farm Tenure `Applications

I. INTRODUCTION

This report is an outline of the regulatory and management framework for salmon aquaculture currently in effect in a variety of jurisdictions in which salmon farming is an important industry. The report has been prepared in connection with the Salmon Aquaculture Review of the British Columbia industry which is being conducted by the provincial Environmental Assessment Office. The report is intended to provide background information for the Review to facilitate comparing the regulatory and management practices employed in other jurisdictions to those in place in British Columbia. It is also intended to provide information regarding practices that could be considered for application, in whole or in part, to address some of the management challenges that have been identified during the Review.

The report provides a general outline of the regulatory regimes in place in the jurisdictions canvassed for the report. However, it is not an exhaustive description of the entire regulatory and management framework in place in each of the jurisdictions referred to in the report.

JURISDICTIONS INCLUDED

The report examines the regulatory and management framework in each of the following jurisdictions:

• Norway• Scotland• New Brunswick• Washington• Alaska• Chile

POINTS OF COMPARISON

In each of the jurisdictions covered in the report, the following points of comparison are discussed:

• Description of Industry• Legislation and Administration
• Siting
• Operating Licence
• Escaped Farmed Fish
• Disease
• Therapeutants
• Transport of Fish
• Interactions with Marine Mammals and Other Species
• Waste Discharges
• Monitoring and Reporting

- Environmental Assessment
- Preventative Measures
- Public Participation in Decision-Making
- Enforcement

In some cases there may be limited information about one or more points of comparison for a particular jurisdiction. This may indicate the lack of a comprehensive regulatory mechanism to address the issue in that jurisdiction, the issue not being of significant concern, or a lack of available information. In other cases where the management approach in a particular jurisdiction offers a new or innovative approach, the description in this report may be more detailed.

II. NORWAY

Description of Industry

Norway produces almost 50% of total world production of farmed salmon. In 1971, production was approximately 600 tonnes. Production has increased significantly since that time, reaching 215,000 tonnes of Atlantic salmon in 1994. It was estimated at 330,000 tonnes in 1995. Atlantic salmon is the dominant species. Approximately 95 per cent of Norway's farmed fish production is exported.

Norway has a long and protected coastline with coastal water temperatures favourable to growing salmon due to the influence of the Gulf Stream. Almost 99 percent of the production occurs in sea water environments. The main farming system employs open fish cages.

Rapid growth of the industry, which resulted in problems such as unacceptable levels of pollution and health problems in the fish, led to regulatory responses, increased research and development, and a preventative medicine approach. The current environmental problems of top priority are reported to be in connection with escaped fish, the spread of disease and the use of space.1

Legislation and Administration

The laws, regulations and policies governing salmon aquaculture in Norway are administered by four different ministries: the Ministry of Fisheries, the Ministry of Environment, the Ministry of Agriculture and the Ministry of Local Government and Labour.

The *Act Relating to the Breeding of Fish, Shellfish Etc*. and regulations adopted under it regulate activities related to fish farming and establish a licensing regime for the industry. The Act is administered by the Ministry of Fisheries. The purpose of the Act is "to contribute towards the balanced and sustainable development of the fish-breeding industry to help it become a profitable and viable industry."2

The Act states that a licence will not be granted if the facility

- will cause the risk of the spread of disease among fish or shellfish,
- will cause the risk of pollution, or
- has a location which conflicts with activities in the surrounding environment, lawful traffic or other exploitation of the area.3

The *Regulations Relating to the Establishment and Operation of Fish Farms* govern the design and operation of fish farms, including provisions for protection of the environment and provide that a "fish farm shall be established and operated in a technically, biologically and environmentally

acceptable manner."4 These regulations were adopted under the authority of the *Act Relating to the Breeding of Fish, Shellfish Etc*. and the Act Relating to the *Supervision of Feeding Stuff* and are administered by the Ministry of Fisheries.

The *Interim Fish Diseases Act* and related regulations deal extensively with the prevention of disease, disease control, the use of medicines and medicated feed, waste treatment and other matters. This Act is administered by the Ministry of Agriculture, Department of Veterinary Services.

The Norwegian Pollution Control Authority, in the Ministry of Environment, issues permits under The *Pollution Control Act* governing waste discharge.

The *Planning and Building Act* regulates siting in relation to local government planning and is administered by the Ministry of Local Government and Labour.

Siting

LENKA (Nationwide Assessment of the Suitability of the Norwegian Coastal Zone and Rivers for Aquaculture) was established during 1987-90 to develop an overview of the potential for aquaculture along the coast and to

provide the basis for the systematic development of the industry. It was a cooperative project involving the Ministry of Fisheries, the Ministry of Local Government and the Ministry of the Environment.5

The objectives of the LENKA program are to

- ensure the balanced and orderly development of the aquaculture industry, and
- provide tools for planning at the county and local level to focus the growth in fish farming to the most suitable areas within the limits of the environment's natural holding capacity and without causing conflicts with other users' interests.

The siting selection criteria applied are as follows:

- the expansion of fish farming is permitted only in salt water with good water exchange and where there are no problems or tendencies toward eutrophication, reduced oxygen concentration or accumulation of sediments under culture systems;
- the expansion of fish farming in freshwater is not permitted; and
- fish farming close to rivers important to wild salmon populations is prohibited.

As part of the LENKA program, a methodology for assessing the suitability of marine areas for aquaculture was developed. As well, a procedure for estimating the gross available capacity for aquaculture production in LENKA zones was developed to allow production figures for each zone to be established.

The main steps in the development of the capacity assessment were:

- an assessment of the maximum permissible organic loading of the water body of the marine area, and
- an assessment of the space available for aquaculture development arrived at by subtracting all unsuitable areas and all areas already occupied from the total area of the zone.

The LENKA method was intended to provide planners with a rough estimate of the amount of aquaculture production that could be attained in a given area without risking environmental degradation and ensuring healthy conditions for the fish in the pens. It also was intended to set out a procedure for eliminating conflicts between fish farming and other interests.

LENKA is not a coastal zone management system in itself, but rather is a planning tool to provide the information base on aquatic capacity to aid in planning.

The scope of the *Planning and Building Act* has been extended to include the sea, so municipalities have begun to develop plans for coastal zones and applications for licences are now sent to the Local Government and Labour Authority for review.

Spacing requirements for salmon farms include the following:

- the distance between each fish farm is to be at least 1 km;
- the distance between a salmon grow-out farm in sea and a broodstock farm is to be at least 3 km.

In the event of a permanent relocation or closure of an installation, the *Regulations Relating to the Establishment and Operation of Fish Farms* establish a duty on the licence holder to remove the equipment and ensure that all refuse is removed within six months.

Operating Licence

The *Act Relating to the Breeding of Fish, Shellfish Etc.* establishes the requirement that all salmon farms must obtain a licence under this Act to operate. The Act provides that a licence is granted for a specific location and size of operation. The licence also authorizes the species of fish that may be raised. If there are changes in these licence conditions, a new licence must be obtained.6

As noted above, the Act contains absolute conditions which describe three situations in which licences will not be granted, related to the spread of disease, pollution and conflicts with other interests.

The Act further provides the authority for the Ministry of Fisheries to stipulate how many licences will be granted for breeding salmon for human consumption, to issue guidelines for the distribution of the licences, and to determine which regions should be given priority. It also states that, when licences to breed salmon are issued, particular emphasis will be placed on

- the activity contributing towards a positive development in the district and for the industry;• local ownership of the facility, as far as possible; and• breeders possessing the necessary professional competence.7

For the purposes of the Act, the term breeding means all activity where live fish are fed and handled with a view to consumption, feed production, reproduction, release, research or education.
The Directorate of Fisheries issues the licences. Each farm is given an official registration number that is used for purposes such as ensuring that medication is used only on licensed fish farms.

Escaped Farmed Fish

The Regulations Relating to the *Establishment and Operation of Fish Farms* provide that a licence holder must ensure that the fish farm is constructed, operated and equipped in such a way that there is no risk of it foundering or causing damage that could allow the fish to escape. The licence holder is also required to ensure that limited but regular fishing is carried out, for monitoring purposes, at a distance of 100 metres from the installation to detect any escape of fish. The Regulations establish a duty for the licence holder to give the regional Director of Fisheries immediate notification if fish have escaped or if an escape is suspected.
The *Act Relating to the Breeding of Fish, Shellfish Etc.* establishes the right of a licence holder to re-catch escaped fish for up to 14 days after escape. It also prohibits anyone other than the licence holder from re-catching fish outside the net-cage when they are found in the vicinity of the farm.
The Regulations add to the right established by the Act and make it a duty for the licence holder to ensure that fish which have escaped are re-caught. This duty applies to the immediate vicinity of the farm, defined as the sea area up to 500 metres from the farm. It applies for a period of five days from the date the escape is discovered. In special cases the Director of Fisheries or the Director's designate may determine that the duty to re-catch fish shall apply to a larger area or may grant dispensation from this provision.8

Disease

The Department of Veterinary Services in the Ministry of Agriculture issued The *Interim Fish Diseases Act* and Other Regulations Concerning Diseases in Aquatic Organisms containing a lengthy set of regulatory requirements aimed at controlling fish diseases, reporting fish diseases, the use of fish medicines, transport of waste, certification provisions for live salmonids and eggs, establishing zones, and the import and export of aquatic organisms.
The *Interim Fish Diseases Act* provides that a salmon farmer must immediately notify the official veterinary officer if there is any reason to believe that aquatic organisms are suffering from or have died of diseases to which Act applies. The Act also prohibits selling, purchasing, or releasing live aquatic organisms if it is clear or there is a reason to suspect that they are infected with diseases covered by this Act. 9
A fish farmer must obtain a veterinary health certificate for smolts before they are placed into the sea. The certificate contains declarations related to inspections and infectious diseases.
The *Regulations Relating to the Establishment and Operation of Fish Farms* provide that the fish density per production unit shall not exceed 25 kg per cubic metre. This provision is intended to prevent stress triggering infectious diseases.

Therapeutants

The *Regulations Relating to the Establishment and Operation of Fish Farms* provide that all medicinal products shall be administered manually unless it can be shown that corresponding or better control can be achieved using other methods.10 They also provide that medicinal treatments must be administered using methods to prevent infiltration to the surrounding environment. The Director of Fisheries may require equipment be used to recover any remaining medicinal products that would otherwise discharge into the environment.

The Regulations also require notification in a prescribed form where medicinal products are used in fish farms. The duty to notify the Director of Fisheries starts when the treatment begins and continues for at least four weeks after the treatment has stopped.

Drugs for fish treatment must be prescribed by a veterinarian applying a standard prescription form, with copies submitted to the Directorate of Fisheries on a weekly basis. 11 Pharmacies and feed-mills also are required to submit to the Directorate copies of all prescriptions. The Directorate of Fisheries compiles all information from prescriptions on a data base. The information is linked to notifications from fish farmers in advance of harvesting. Regulations set minimum withdrawal periods for drugs used in medicinal treatment of fish. Laboratory examinations must be done in advance of harvest for all fish treated with antibiotics or chemotherapeutics during the last 12 months.

The Directorate of Fisheries performs more than 20,000 analyses annually to test for residues of antibiotics or chemotherapeutics in farmed fish to ensure the withdrawal periods are followed and no treatment is performed without the required prescriptions and registrations.12

Transport of Fish

Regulations govern the transport of smolts by boats, cars and helicopters to avoid smolts being infected during transport.

As a method of controlling diseases, the *Regulations Concerning Diseases in Aquatic Organisms* authorize establishing geographic zones in which special measures against the dissemination of disease are enforced. These measures could include banning the movement of live aquatic aquaculture organisms in and out of a zone, restrictions on transfer of fish between farms and special rules and restrictions regarding the transport of fish and the means of transport.

Interactions with Marine Mammals and Other Species

The *Regulations Relating to the Establishment and Operation of Fish Farms* provide that, if needed, facilities must be covered with netting or other covering to keep birds out.

Fish farming close to rivers which are important to wild salmon populations is prohibited.

Waste Discharges

A permit is issued under The *Pollution Control Act*, taking into account the pollution potential of organic matter to be discharged and the competing interests in the area, such as nature conservation, wildlife and recreation. The Pollution Control Authority has identified goals for reducing pollution in connection with eutrophication, toxic effects and effects of organic matter, oil and chemicals.

The *Regulations Relating to the Establishment and Operation of Fish Farms* provide that cleaning fish and storage of dead fish must not cause annoying odors or serious harm to the environment. The Regulations also prohibit dumping of fish or fish parts. Dead fish must be ground and preserved in acid, although other procedures may be approved if they are shown to better prevent infection and pollution. Further, dead fish must be removed from the nets every day in the summer and every other day in the winter. If a fish farm has a high mortality rate or an outbreak of disease, dead fish must be removed every day.

The *Waste Treatment Regulations*, issued by the Ministry of Agriculture under the *Interim Fish Diseases Act*, set out approved methods and equipment for the destruction of dead fish and wastes and the treatment of effluent from a salmon farm to prevent the spread of infection. Dead fish may be disposed of by incineration, burial at an approved site or delivery to an approved rendering plant. These Regulations also provide the criteria and procedures for approving other new methods and equipment for treating dead fish and effluent originating from aquaculture activities.

Monitoring and Reporting

The Regulations Relating to the Establishment and Operation of Fish Farms require that a fish farm must be inspected daily and regular maintenance performed. A fish farm also must be inspected immediately after any bad weather. Operating and maintenance activities must be recorded in accordance with prescribed rules and records kept on the premises for at least five years. Those records must be submitted on inspection.

The *Regulations Concerning Diseases in Aquatic Organisms*, issued by the Department of Agriculture under the *Interim Fish Diseases Act,* require records be kept on fish farms, for at least five years, of

- all ingoing and outgoing live aquatic organisms,
- slaughter and loss of aquatic organisms through escape or mortality, and
- health certificates accompanying live organisms entering the fish farm.

The *Interim Fish Diseases Act* authorizes the veterinary officer to enter facilities where fish diseases covered by the Act may occur and carry out investigations as are deemed necessary.13

There are specific reporting procedures for the use of antibiotics and other drugs for treatment of farmed salmon. Drugs for treatment are only obtainable by veterinary prescriptions, which are written on standard forms. The Directorate of Fisheries receives copies of all prescriptions weekly. Fish diseases also are reported to the veterinary authority on a standard notification form. These reporting systems are in general available to the public.14

Environmental Assessment

It is the responsibility of the fish farmer to demonstrate that a farm will not cause unacceptable pollution effects and that there is a plan for handling waste, such as mortalities, prior to establishing or expanding a fish farm. If it is unclear if the receiving environment will be suitable, a monitoring program is required prior to licensing the proposed operation.

Preventative Measures

A finfish licence will not be granted if there is a risk of water pollution, spreading of diseases or if the welfare of the community so requires. A licence may be withdrawn if the facility causes or is at risk of causing the spread of disease or pollution.

As noted above, a fish farm must be constructed, operated and equipped so that there is no risk of foundering or causing damage that could allow fish to escape.
Salmon farmers must have a plan for handling waste, including specific provisions to be employed in the event of a mass mortality.
The limit on stocking density of 25 kg per cubic metre is intended to reduce stress and therefore prevent disease.

Public Participation in Decision-Making

Information reported to authorities regarding facility operations and the use of antibiotics and other drugs is generally available to the public.

Enforcement

The Act *Relating to the Breeding of Fish, Shellfish Etc.* provides that a licence issued under that Act may be withdrawn if the facility causes or involves the risk of causing substantial damage by the spread of disease among fish or shellfish or by pollution or if the facility causes conflicts with activities in the surrounding environment, lawful traffic or other exploitation of the area due to its location. However, the licence may not be withdrawn if the damage can be repaired or the location changed by order of the authorities.15
This Act further provides that if a salmon farm that is in violation of the Act or regulations under it the Ministry may order measures to stop the unlawful activities. The Act also provides for fines and for the Ministry to recover expenses incurred in implementing a decision under the Act. Gross or repeated violations of the Act may lead to withdrawal of a licence by the Ministry.

III. SCOTLAND

Description of Industry

Salmon farming was introduced in Scotland in the 1960s but the industry remained small through the 1970s. However, there has been a steady increase of production of farmed salmon over the past decade with production reaching about 70,000 tonnes in 1995 and estimated to be 83,000 tonnes for 1996. At the rate of growth experienced over the past 4 years, production is expected to be about 132,000 tonnes in 2000. In 1995, 69 companies operated 162 sites for smolt production and 108 companies operated 268 active marine salmon farm sites in Scotland. In addition, another 91 sites were fallow to control parasite build-up. 16

Finfish farming is widely distributed along the coasts of Strathclyde and Highland Regions and the Western and Northern Isles. The Atlantic salmon is the only finfish species currently farmed on a major scale in Scottish coastal waters.

Overall, the average farm size has increased from 85 tonnes in 1985 to 355 tonnes in 1995. However, the average production at the 45 largest sites was 900 tonnes and at the remaining sites was about 200 tonnes. 17

Sea cage culture in sea lochs, where Atlantic salmon are the primary species raised, is one of the four major forms of commercial fish farming in Scotland. To date, most marine salmon aquaculture production in Scotland has occurred in sheltered areas such as fjord-like sea lochs or voes. Typically these sites do not have good water exchange properties, so the licensing and placement of cages must be sensitive to current conditions to prevent an accumulation of solid wastes. However, as cage design and mooring technology has improved, some operators have moved into more open waters to allow a wider dispersal of effluent from farms and reduce the environmental effects.18

Legislation and Administration

The rapid expansion of fish farming in Scotland has resulted in the development of a coherent regulatory system lagging behind the growth of the industry. The present system focuses on three approaches:

- controlling the location of the fish farms;• controlling the effluent discharged; and• monitoring the impacts of the effluent after the development is in operation.19

The Scottish Office has the main responsibility for co-ordinating the regulation of the marine fish farming industry and for ensuring that relevant European legislation is transferred into Scot's law.

The Scottish Office Development Department has responsibility for co-ordinating the planning regulations. Several other regulatory bodies also have statutory responsibility for some aspects of the regulation of marine fish farming, such as the Crown Estate, the Scottish Environment Protection Agency and the Scottish Office Agriculture, Environment and Fisheries Department.

The Crown Estate office carries out the main siting functions for salmon aquaculture, approves and administers leases, consults with relevant parties and charges rent for the use of sites.

The Scottish Environment Protection Agency was established by the *Environment Act*, 1995, bringing together the regulatory powers of various organizations including those of the ten River Purification Authorities, the authorities that previously issued consents to discharge effluent from fish farms into a sea area. The Scottish Environment Protection Agency's main function is to protect the environment by controlling pollution to land, air and water in Scotland. In relation to salmon farming in marine and tidal waters, some of this agency's specific duties include

- the promotion of the cleanliness of tidal waters,• the conservation and enhancement of the natural beauty and amenity of coastal waters, and• the conservation of aquatic flora and fauna.

The Scottish Office Agriculture, Environment and Fisheries Department has wide responsibilities for protection of fish, fisheries and the marine environment. It advises the Crown Estate, which is responsible for leasing sites for salmon farms, on the implications of leasing applications in connection with disease control, existing fishing interests and the inshore marine environment. The Scottish Office Agriculture, Environment and Fisheries Department is responsible for statutory measures under the *Diseases of Fish Acts* 1937 and 1983 and the *Sea Fisheries (shellfish) Act* 1967. These Acts are designed to prevent the introduction and spread of pests and diseases of fish and shellfish that could affect farmed and wild stocks. Under this legislation, all fish farms are required to be registered with the Scottish Office Agriculture, Environment and Fisheries Department and must notify the Department of certain diseases.20

The Veterinary Medicine Directorate is responsible under the *Medicines Act* 1968 for issuing a marketing authorization for any substance intended for use as a veterinary medicine.

The Department of Transport is responsible for ensuring that works in tidal waters do not constitute a navigational hazard. Under the *Coast Protection Act* 1949, the Department's Marine Directorate must consent to the installation of fish farming equipment in sea areas.21 The primary concern is with the effects on navigation generally and on certain anchorages and restricted channels. Consents which are issued usually stipulate lighting and marking conditions. For administrative ease, the lease application to the Crown Estate is also treated as an application for navigation consent.*22*

In relation to local authorities, all development above the low water mark is subject to control under planning legislation. The relevant local planning authorities have responsibility for assessing and siting of any onshore facilities for a marine cage fish farm. Some local planning authorities have set up local area framework plans covering marine fish farming.23 Also, in the waters around Shetland and parts of Orkney and in certain other designated harbour areas, anyone wanting to operate a fish farm must obtain a works licence from the local harbour authority.

The Scottish Natural Heritage is the statutory guardian of Scotland's natural heritage and is consulted by the Crown Estate and the Scottish Environment Protection Agency in connection with granting fish farm leases and consents to discharge.

The recently created Scottish Environment Protection Agency has released a consultation paper24 outlining the marine cage salmon farming industry and possible future trends. The paper identifies the major issues associated with the present status and anticipated future expansion of the industry and presents options to address these issues. Comments on the paper were invited from the public up to May 31, 1997. It is possible that the Scottish Environment Protection Agency will take over additional planning responsibilities for salmon farming in the future, possibly amalgamating some functions now carried out by separate agencies.

Siting

The territorial seabed and most of the foreshore between the high and low water mark are part of the Crown Estate. Anyone wanting to establish a salmon farm must apply to the Crown Estate Commissioners under the *Crown Estate Act* 1961 for a lease to the area of seabed where the salmon farm will be located.25

The application for a lease must specify the position and size of the proposed site, the types and dimensions of equipment, the species to be farmed and the target output, and any requirement for onshore facilities. Applicants also are encouraged to provide information about why the development is required, the reasons for selecting the proposed site, the employment expected to be provided and any measures proposed to safeguard

other interests. The Crown Estate Commissioners or other authorities may request further information before or during the processing of the application.

Since development above the low water mark is subject to control under planning legislation, permission for an onshore facility is needed from the relevant local planning authority. In addition, the relevant planning authorities are asked to identify any onshore constraints and to provide general views on the proposal.

After receiving an application for a salmon farm lease, the Crown Estate Commissioners invite comments from the public, other government agencies and non-government organizations, such as fishers and conservation groups. In addition, applications are advertised in the newspaper and the

application form and plans are exhibited in an appropriate post office. Copies are sent to a wide range of relevant parties. Comments about the proposed application are to be submitted within 28 days after the advertising and circulation, if possible.

As noted above, before a lease can be granted consent is required from the Department of Transport under the authority of the Coast Protection Act 1949. This also requires consultation with a list of key bodies and interested parties.26

The Crown Estate Commissioners conduct a detailed appraisal of the comments received and the possible effects of the proposed salmon farm on navigation, sailing, fishing, amenity, ecology and existing fish farmers. 27 Where conflicts exist, the Crown Estate Commissioners may ask the applicant for modifications of the proposal prior to making a decision about whether or not to approve the application.

In addition, an independent Advisory Committee has been established to advise on particularly contentious lease applications. The Chair and Deputy Chair are appointed by the Secretary of State and its members are from other relevant statutory bodies. If one of the statutory bodies raises an objection to a proposed salmon farm development, it will be referred to the Advisory Committee. The Chair may recommend that an application which raises particularly difficult issues should be referred to the Secretary of State for advice. The Crown Estate Commissioners will act appropriately on the advice from the Secretary of State, when given.28

The Crown Estate office established the *Fish Farming—Guidelines on Siting and Design of Marine Fish Farms in Scotland* in December 1987 and revised them in 198929 in an effort to guide marine fish farmers on siting issues and to reduce conflicts with other fish farmers and with fishing, recreation and conservation interests. These are guidelines rather than regulations. It is contemplated that longer or shorter spacing distances may be appropriate, depending on the specific circumstances of each potential site including hydrography, topography, access and existing development. Also, management agreements or other forms of co-operation may allow closer siting.

The spacing guidelines include the following separation distances for finfish farms:

- 5 miles from another finfish farm, although closer siting may be possible between small-scale farms and in large loch systems or open water (this guideline apparently was developed primarily from suggestions made by the salmon farm operators and is not backed by scientific assessment of the hazards of disease transmission30);
- 2 miles from a shellfish farm;

- 1 mile from public viewpoints, hotels and tourist centres although concealment by headlands or woodlands may permit closer siting;
- 1 mile from houses other than staff residences although the attitudes of residents are to be taken into account and may permit closer siting;
- 0.5 miles from wildlife colonies, assuming effective anti-predator control;
- 0.25 miles from anchorages and approaches subject to the assessment of the Department of Transport;
- 0.25 miles from fishing grounds, assuming that the fishing grounds concerned are specific productive areas in frequent use.31

On granting a lease the Crown Estate Commissioners levy an annual rent based on the level of production for the salmon farm.

Operating Licence

There is no requirement in Scotland for a salmon farm to obtain an aquaculture licence to operate a salmon farm.32

Escaped Farmed Fish

Concerns exist about the effects of fish that escape from salmon farms on the wild salmon populations, such as possible adverse genetic effects and the risk of disease transmission. Due to the importance of minimizing potential risks to wild salmon stocks, the Crown Office has provided that salmon cages should not be located in marine waters close to the mouths of salmon rivers.33

The unauthorized introduction of salmon into waters may constitute an offence in Scotland. An offence will be committed where a person releases or allows to escape any fish which is of a kind which is not ordinarily resident in Britain or is listed in a schedule to the *Wildlife and Countryside Act* 1981. Also, the *Salmon Act* 1986 provides that a person who intentionally introduces any salmon or salmon eggs into inland waters in a salmon fishery district for which there is a salmon fishery board is guilty of an offence.

In addition, the introduction of fish of a genetically different character to wild stocks may have a detrimental effect upon fisheries, either through ecological competition or by adverse genetic effects upon native stocks. Where this can be shown to cause damage to fisheries in the locality of the escape it is, in principle at least, capable of giving rise to civil liability.

When farmed fish have escaped, a fish farmer wanting to recover the escaped stock using other than a permitted fishery method will commit an offence unless the farmer obtains an exemption from the Secretary of State or, in certain cases, from the district salmon fishery board. 34

Disease

The Scottish Office Agriculture, Environment and Fisheries Department is responsible for administering the requirements under the *Diseases of Fish Acts* 1937 and 1983. Although salmon farms do not require a general operating licence, all fish farms must be registered with the Scottish Office Agriculture, Environment and Fisheries Department as a measure aimed at controlling disease.

There are additional requirements that fish farmers notify the Scottish Office Agriculture, Environment and Fisheries Department about specific diseases and procedures for treatment and disposal of infected stock.

The regulations also authorize the Scottish Office Agriculture, Environment and Fisheries Department to carry out annual surveys and report on the fin fish industry.

Therapeutants

Most chemicals used for disease control in fish are covered by the *Medicines Act* 1968 and the Veterinary Medicines Directive. The Act regulates the manufacture, import, sale and supply of medicinal products and prohibits the marketing of a product without a product licence, now called a marketing authorization, issued by the Veterinary Medicines Directorate. A marketing authorization may be granted if standards are satisfied governing safety, quality and efficiency of the product and a drug is shown not to be harmful to animals, handlers, consumers and the wider environment.

The Veterinary Medicines Directorate is advised by an independent Veterinary Products Committee.

Most medicines, including all prescription only medicines, are administered under the guidance of a qualified veterinarian. Medicines which have not been licensed for use on farmed fish can be prescribed where treatment is found to be necessary and all other licensed alternatives are discounted as not being effective. When this occurs, the *Medicines (medicated feeding stuffs) (No. 2) Regulations 1992* require the veterinarian to make a series of decisions referred to as the "cascade principle." Any question about whether this principle has been incorrectly applied may be referred to the State Veterinary Service, a function of the Scottish Office Agriculture, Environment and Fisheries Department, for investigation.35

The Scottish Environment Protection Agency is responsible for control and monitoring of the discharge of medicines and chemicals into the receiving waters. Due to the increasing range of available sea lice treatments and the public interest in them, control and monitoring of sea lice chemicals is a high priority for the Agency. Prior to issuing consent, a risk assessment of the chemical is conducted involving a review of scientific data on the characteristics of the chemical and its environmental threats such as toxicity, persistence and bioaccumulation. The Veterinary Medicines Directorate also is involved in this process. The decision about whether to permit the discharge of sea lice treatment chemicals at each salmon farm depends on site specific models which use local hydrographic data to predict the scale of discharge which can occur without breaching short term environmental quality standards. An assessment of the wider cumulative impact within each hydrographic area is based on compliance with long term environmental quality standards.

Transport of Fish

There is a prohibition against importing live salmonids to Great Britain unless authorized under a ministerial order. Imports of ova, freshwater fish and their ova are permitted only with a licence and supporting health certification.36

Interactions with Marine Mammals and Other Species

The Crown Estate *Guidelines on Siting Procedures & Principles*37 for marine fish farms provide for a separation distance of half a mile between salmon farms and wildlife colonies. This distance is based on the assumption that effective measures are taken, such as the installation of anti-predator nets.

In general, finfish farms are not to be located in close proximity to important seabird colonies, heronries or seal haulouts and breeding areas.38

Industry and wildlife conservation organizations have agreed codes of practice in relation to interactions between fish farming and predatory wildlife. The Scottish Natural Heritage provides advice on acceptable methods of predator control against seals and eider ducks.39

The *Conservation of Seals Act 1970* imposes a basic prohibition against using certain methods of killing seals, subject to exceptions such as allowing the killing or taking of the seal pursuant to a licence granted by the Secretary of State. The killing of seals is lawful only when in season. While again there are exceptions to this general rule, these exceptions are not aimed at the killing of seals as a means of fish farm predator control and it is not clear if any of the exceptions would apply for that purpose. This issue has not yet been authoritatively resolved.40

The *Wildlife and Countryside Act 1981* imposes wide-ranging prohibitions upon the killing or taking of birds or other wild animals. Two exceptions may be applicable to fish farms. The first is an exception allowing for the killing or injury of a wild bird, other than certain rare species, by an "authorized person" for the purpose of preventing serious damage to livestock or fisheries. The second is where the killing is authorized by an appropriate licence.

In respect of other wild animals, only those specifically listed in a schedule to the Act are protected. Of those animals given the protection, the only one likely to be a fish farm predator is the otter. Except in the case of the otter, it is generally lawful to employ humane destructive methods of predator control in relation to wild animals other than birds. In the case of otters, a salmon farmer may not be guilty of an offence if the farmer shows that killing the otter was necessary for the purpose of preventing serious damage to livestock or fisheries.41

Waste Discharges

Under the *Control of Pollution Act 1974*, as amended by the *Water Act 1989*, all salmon farms must have a licence known as a Consent to Discharge issued by the Scottish Environment Protection Agency to control the discharge of pollutants into fresh waters and coastal waters up to three miles offshore. These consents were formerly iss

It has been noted that there is a lack of sufficient resources to effectively monitor Consents to Discharge in all areas. The Western Isles Council inspects farm sites twice each year to assess the aesthetic quality of shores in the vicinity of cage sites and to examine sea lice treatments.

In some cases, the Consent to Discharge contains a condition requiring a fish farm to conduct and report using self-monitoring and monitoring by authorities takes the form of an occasional audit to verify the data. For example, one area's self-monitoring regime requires collection of sediment cores near each cage group and at a control site.

The Scottish Environment Protection Agency has made numerous recommendations in its consultation paper44 to improve site inspections and environmental monitoring of the effects of medicines and chemicals, nutrients, and organic and other waste. It has identified that the regulation and monitoring proposed will require significant additional resources and has suggested options for providing those resources.

Environmental Assessment

Under recent Scottish Office Guidelines, an environmental assessment should be conducted based on the following thresholds and criteria:

Very Sensitive Areas:

all proposals for new salmon farm sites or significant modifications at existing sites ("significant modification" is any increase of more than 25% in lease area or equipment which would result in a lease area of more than 6,000 m2 or a cage area of more than 2,000 m2).

Enclosed Inshore Areas:

in sea lochs and other enclosed inshore areas, any development with a proposed annual output of over 250 tonnes or total cage area of over 6,000 m2 or any development or expansion of a development which would result in either of these limits being exceeded within a 2 km radius of existing development.

Open Sea Areas:

in open sea areas within 2 km of the coast, any development with a proposed annual output of over 500 tonnes or total cage area of over 12,000 m2, or any development or expansion of a development which would result in either of these limits being exceeded within a 2 km radius of an existing development.

An environmental assessment also may be required for development proposals which fall below the thresholds for enclosed inshore areas and open sea areas where the impact on the environment is considered significant. If an environmental assessment is required, the applicant must submit an environmental impact statement with data to describe and assess the proposed salmon farm and its overall effect on the environment, measures proposed to avoid, reduce or, if possible, remedy any adverse effects, and procedures for monitoring the impact over time.

Specific information required in the statement includes:

- details about the proposed location, a description of the area, the location of other salmon farms and leases, and the reasons for selecting the proposed site;
- information about the type, size and arrangement of proposed equipment, details about proposals for rotation or fallowing, if any, and a description of production methods, stocking levels and outputs;
- a description of the methods of installing, maintaining and operating equipment, management proposals for controlling disease and predators and for disposing of dead fish and other debris, and an indication of projected staffing levels, including the types and numbers of jobs;

- a description of any new onshore developments, including new piers or jetties, and the proposed access arrangements;
- an assessment of existing marine conditions and hydrography, estimates of levels of effluent and chemical discharges, an evaluation of the effect of the project on water quality, seabed conditions and ecology of the area, and a statement of measures to minimize the potential effects;
- an assessment of the existing landscape character and a description of the measures proposed to safeguard any visual amenity;
- information on the location and distribution of existing wildlife and an assessment of the potential effect on wildlife, including wild fish stocks;
- an assessment of the potential effect on existing marine activities and recreational interests and a description of navigation and management agreements struck with other local interests; and
- a description of the procedures and methods for monitoring short and long term effects of the project on the environment.45

The Crown Estate office has the discretion to not require an environmental assessment to be conducted, even when the thresholds noted above have been met. Apparently, this environmental assessment process has not been used extensively to date.46

Preventative Measures

The environmental assessment process, if employed as intended, could assist in preventing some of the impacts associated with salmon farming in Scotland's marine areas.

Public Participation in Decision-Making

There are consultation procedures in place for inviting and receiving comments, for a 28-day period, from the public on fish farm lease applications. Applications are advertised in the newspaper and copies are sent to relevant parties.

The Scottish Natural Heritage and other environmental and conservation organizations are consulted on lease applications.

Enforcement

Due to the number and remote locations of salmon farms, agencies have often not had sufficient resources to adequately monitor whether regulatory requirements are being met and initiate enforcement measures, where necessary. 47

IV. NEW BRUNSWICK

Description of Industry

Aquaculture is a rapidly growing industry in New Brunswick. Atlantic salmon is the dominant species raised, representing about 95% of aquaculture production in the province. In fact, most of the salmonid culture in Atlantic Canada occurs in southern New Brunswick.

Salmon farming started in southwestern New Brunswick in 1979 with a small harvest valued at $45,000.48 The industry has grown significantly since then and, in 1996, the total production of farmed salmon in New Brunswick was estimated at more than 16,000 tonnes, worth approximately $122 million.49 Salmon production in the Bay of Fundy, where salmon farming is concentrated in this province, is estimated to reach 20,000 tonnes by the end of this decade.

In general, the East Coast of Canada is chilled by the Labrador Current bringing waters from the Arctic Ocean along this coast. The resulting low water temperatures makes salmon farming difficult in many locations. The southern coast of New Brunswick is one of the relatively few areas that has winter temperatures above the minimum lethal temperature for salmonids.50

Legislation and Administration

The Department of Fisheries and Oceans and the province of New Brunswick signed a memorandum of understanding in 1989 directed at the orderly development of aquaculture and the establishment of a coordinated system of licensing and leasing of commercial aquaculture ventures. The province is responsible for the promotion, training and development of aquaculture and the management and issuance of leases and operating licences for aquaculture facilities. The agreement provides for the establishment of coordinating committees to ensure interagency cooperation regarding the management, promotion and development of aquaculture.

The Department of Fisheries and Oceans has appointed an aquaculture coordinator to coordinate among federal agencies the review of aquaculture applications for aquaculture licences and leases, the securing of required permits, and other aspects affecting aquaculture. The applications are forwarded to the Department of Fisheries and Oceans from the province.51

The Department of Fisheries and Aquaculture is the primary provincial agency responsible for aquaculture in New Brunswick. It deals with aquaculture development and infrastructure, issues licences and leases, and conducts inspections.

The provincial Department of the Environment is responsible for the *Clean Environment Act*, the *Clean Water Act* and the *Pesticide Control Act*. It reviews applications for permits for freshwater and water-course alterations and issues permits for the use of chemicals and pesticides.

The provincial Department of Natural Resources oversees the management of Crown lands and natural resources within the province but has transferred the administration of Crown lands approved for aquaculture use to the Department of Fisheries and Aquaculture.52

In 1988, New Brunswick passed legislation, the Aquaculture Act,53 specifically aimed at the administration and regulation of the practice of aquaculture within the province. The *General Regulation—Aquaculture Act*54 was adopted under the Act in 1991, setting out detailed requirements related to siting and operations.

Siting

The Department of Fisheries and Aquaculture is responsible for issuing aquaculture leases and aquaculture licences, both of which are subject to operating terms and conditions established within the framework of the

Aquaculture Act and the *General Regulation—Aquaculture Act*. These conditions include placing limitations on the area or size of a site and the level of production for any given operation.

An aquaculture lease, which may be issued for a period of up to 20 years, is required where the operation is to be conducted on public lands owned by the province. Generally, all marine finfish operations in the province are located on provincially owned public land. An aquaculture occupation permit allows the salmon farmer to occupy and use a site for a temporary period of up to three years.55 Both a lease and an occupation permit are subject to the terms, covenants and conditions that are established by regulations either before or after the lease or permit is issued and any other terms and conditions set by the Minister in the lease or permit.56

The Department of Fisheries and Aquaculture, in consultation with the Department of Fisheries and Oceans, the New Brunswick Department of Environment and the New Brunswick Salmon Growers Association, has developed guidelines to determine the size and production level for each site, based on the following objectives:

- boundaries are established for aquaculture sites to ensure a sufficient area is available for an economically viable level of production while minimizing the impact of the removal of that area from public use—allowance may be given for potential growth of the site within the established limits depending on the specific characteristics of the site;
- production levels are set for an operation to ensure economic viability for commercial production in consideration of the environment's ability to sustain that level of production at that site;
- the criteria for evaluating and placing limitations on both site approvals and expansions are applied equitably to all operators considering the commercial needs of the industry, the impact on public resources and environmental sustainability.57

Production levels are based on the environment's capacity to sustain aquaculture development at that particular site. Factors used to determine this include:

- water depth,• total site area,• current or flow rates,• bottom type,• cage size,• water quality,• husbandry, and• management practices.58

A method of determining the estimated site potential (ESP) has been developed for new or expanding salmon aquaculture sites in the Bay of Fundy. The ESP is an estimate of the maximum number of fish which may be permitted on an aquaculture site at any time. It is calculated using a formula which takes into account the following factors:

- the total approved area of the site below mean low tide, in square metres;• the percentage of the surface area which may be used for the cages, excluding walkways;• the average net depth of 6 metres;• a minimum site depth of 8 metres at mean low tide, as set under the *General Regulation—Aquaculture Act*;• a maximum stocking density of 18 kg per cubic metre;• the average market weight of cultured salmon from a salmon farm in the Bay of Fundy, being 4.5 kg.59

The maximum start up production on a site is recommended not to exceed 70% of the estimated site potential.

The minimum site criteria for new aquaculture sites culturing finfish is set under the *General Regulation—Aquaculture Act.* Sites must have a minimum of 8.0 metres in depth in the area of the cages and must be at least 300 metres from other aquaculture sites, herring weirs, wharves, lobster pounds, and other marine structures.

The recommended environmental standards that are set to ensure long term viability of an operation while minimizing the risk of seabed degradation are as follows:

- the average current speed at the centre of any proposed or existing cage clusters should be no less than 5 cm per second (10 cm per second is noted as being preferable);

- sediment samples at the centre of any proposed or existing cage clusters should be no more than 65% silt/clay;
- there should be at least 5 metres of clearance at mean low tide from the bottom of the cage nets to the seafloor, necessitating at least 13 metres of water at mean low tide to allow for bagging of a 6 metre net to 8 metres at the centre of the cage.

These environmental standards are based on information collected through ongoing site monitoring and research conducted by various agencies. The criteria are used to assess a proposed aquaculture site as well as in the subsequent evaluation of existing operations that may want to increase production. If a site does not meet these criteria, it may still be approved in some cases but may be constrained to less than 70% of the estimated site potential.

The review process for leasing and licensing of salmon farm sites begins with the applicant filing an application and a Site Development Plan together with the appropriate fee.60

The aquaculture application form for marine finfish requires applicants to submit information to determine that the site criteria will be met. The data required include

- information about the proposed location of the site,
- the species and the number of each species to be cultured,
- the number of cages and total rearing space required, and
- specific site criteria, such as • details of any potential conflicting uses within 350 metres of the proposed site, such as commercial fisheries activities, landowner use or recreation use, • whether the site is within 300 metres of another aquaculture site, a herring weir, a lobster pond or another marine structure,• whether all site boundaries are further than 45 metres from the mean low water mark, • whether all anchors, moorings, and other submerged equipment will be at least 2 metres of water at mean low water, and • whether there is a minimum depth of 8 metres of water, during mean low water, where cages will be placed.61

All applications for new salmon farms or to amend existing site boundaries must be accompanied by a Site Development Plan. This is a plan or series of plans that have been drawn to scale showing the proposed aquaculture site and identifying what will be placed on the site.62 The plan must be prepared and signed by a professional, such as a land surveyor or engineer. The plans show the proposed site layout including the type and size of all structures or equipment to be placed on the site. Generally the Site Development Plan is more than one plan showing two levels of information drawn at two different scales. The first plan contains general information about the site and surrounding area. The second contains more specific details about the site and anything within the site boundaries.63

After receiving the application form at the regional office, a site evaluation is conducted and the application is sent to the Registrar, who is appointed by the Minister of Fisheries and Aquaculture under the *Aquaculture Act*. The Registrar initiates the public notification process, as described below, and an interagency review.

The interagency review is coordinated by the Department of Fisheries and Aquaculture and consists of sending the applications to other provincial and federal government departments. The provincial departments are Natural Resources and Energy, Environment, Municipalities, Culture and Housing and Supply and Services. The federal departments are Fisheries and Oceans, including the Coast Guard, Environment Canada, Public Works and Atlantic Canada Opportunities Agency (ACOA). Other government agencies may be included, depending on the circumstances.

The Department of Fisheries and Agriculture requires pre-site evaluations of all site applications and boundary amendments to determine whether the area tends to be depositional, that is, containing fine, silty sediments, or erosional in nature and to identify any unique features. The site evaluations are coordinated by the Regional office of the Department of Fisheries and Aquaculture at the applicant's expense.

Following the period for public comment, an Aquaculture Site Evaluation Committee meets to review the applications for new leases or licences or amendments. The Committee has representatives from Fisheries and Aquaculture, Natural Resources and Energy, Environment, the Coast Guard, the Department of Fisheries and Oceans, and ACOA. A summary of the application review and the public input is prepared for this Committee which then reviews the application and makes comments for consideration by the Department of Fisheries and Aquaculture.64

Following this review, the Registrar of Aquaculture will advise the applicant of the licensing decision. If the application is not approved, the Registrar's decision may be appealed to the Minister of Fisheries and Aquaculture by the applicant within 30 days.

Based on the public comments, the application review and the comments from the Aquaculture Site Evaluation Committee, the Minister of Fisheries and Aquaculture decides whether or not to issue a lease. The Minister's decision is final and cannot be appealed.

For operations requiring an aquaculture lease or occupation permit, the site must be in an area which has been designated by the Minister of Fisheries and Aquaculture as aquaculture land. Before the Minister may designate land as aquaculture land, the Minister must give notice of the intended designation.65

Operating Licence

The *Aquaculture Act* requires anyone carrying on aquaculture to hold a licence that is issued under the Act. The aquaculture licence controls the operations at the site and specifies the species to be grown on the site, the numbers of fish permitted on the site, the cage capacity and the environmental monitoring required.

The aquaculture licence may include site specific or general requirements relating to

- adherence to an aquaculture Site Development Plan,
- standards for site utilization, stocking densities and production,
- measures to minimize risk of environmental degradation,
- measures to prevent escape of farmed fish,
- measures to minimize risk of disease, parasites, toxins or contaminants spreading to other sites, and
- measures to ensure maintenance of health and genetic standards.66

An aquaculture licence may be issued for up to 20 years, but the duration of the licence must not be longer than the tenure that has been granted.

As noted above, an applicant for an aquaculture licence can appeal a licensing decision to the Minister, whose decision is final.

After an aquaculture site has been approved, pre-development data must be collected prior to development of the site. The data collection is coordinated by the Department of Fisheries and Aquaculture at the expense of the proponent. This data includes measurements of the range of current speeds and directions at a specified point over the full tidal cycle. As well, the following data is collected at specified points:

- depth at mean low tide;• core samples to determine the percentage of silt and clay and the percentage of organic sediment, the type, thickness and colour;• the abundance of all fauna;• the abundance of all flora;• redox measurements; and• any unique characteristics.

A control point is to be established 100 metres outside the site boundary and the data listed above must be collected at the control point.67

In addition, the surveyor retained by the salmon farmer must prepare a Plan of Aquaculture Survey for filing with the Crown Lands Branch of the Department of Natural Resources and Energy. This Plan also must be approved by the Regional Aquaculture Development Officer in the Department of Fisheries and Aquaculture. The lease is issued after this Plan has been approved and filed.

Next, the salmon farmer is required to have the surveyor prepare a second plan called a Surveyor's Aquaculture Site Report showing all equipment, including all anchors, mooring lines and cages along with their dimensions and offset distances to the nearest site boundaries. This plan must be submitted to the Regional Aquaculture Coordinator at the Department of Fisheries and Aquaculture within 120 days of the later of the execution date of the lease or its commencement date.68

Escaped Farmed Fish

As noted above, the aquaculture licence may contain provisions to prevent escape of farmed salmon.

The aquaculture licence specifies the species and strains of fish that may be cultivated under that licence.69 There are restrictions on the species approved for culture in the Bay of Fundy and only the Saint John River strain of Atlantic salmon are authorized.70

Disease

A salmon farmer must immediately report the presence of disease, parasites, toxins or contaminants to the Minister or an inspector. The Minister may require measures to prevent the spread of the disease, parasites, toxins or contaminants. In some circumstances, the Minister may order a salmon farmer to quarantine or destroy fish.71 However, no one may destroy diseased fish except under the direction of the Minister.72

Upon the request of the Registrar, a licence holder must provide weekly mortality records for each unit containing finfish.73

All salmon farmers operating marine sites must have a sample of five moribund fish per year class that do not have antimicrobial residues collected once a month six times in each year by an approved fish health diagnostic service. Fish must be tested for aeromonas species, enteric redmouth disease, vibrio and bacterial kidney disease.74

Therapeutants

An aquaculture licence holder must, within seven days after receiving written or verbal information about any diagnostic work or treatment, submit a written report to the Minister. The report must contain the name, dosage and total amount of any drug or chemical agent administered, the time period in which the drug or chemical agent was administered, the temperature of water at the time, and the number of fish treated.75

In 1993, New Brunswick adopted new criteria for controlling the withdrawal period for oxytetracycline (OTC), based on the dose and the water temperature.

Transport of Fish

As is the case in British Columbia, salmon farming in New Brunswick must be conducted in compliance with the federal *Fish Health Protection Regulations*76 which were brought into effect under the authority of the federal Fisheries Act to address concerns about possible fish disease transfer due to the movement of live fish and fish eggs into the country and across provincial boundaries.

The transfer or transport of live fish also must be conducted according to provisions in the provincial *General Regulation—Aquaculture Act*. These regulations contain requirements for a variety of situations. In each case, the requirements must be followed unless the person has first obtained the written approval of the Minister of Fisheries and Aquaculture.

First, no one may move live finfish from an inland aquaculture site to the marine environment unless an approved fish health diagnostic service

- collects from the group of finfish 60 finfish per species per year class that do not contain antimicrobial residues and determines that the finfish do not have furunculosis; and
- tests moribunds for antimicrobial residues and determines they do not have bacterial kidney disease.

Second, no one may move finfish from one marine aquaculture site to another unless an approved fish health diagnostic service

- collects a sample of 60 finfish per species per class year that do not contain antimicrobial residues, or
- collects a smaller sample that does not have antimicrobial residues and tests are conducted to ensure the fish do not have aeromonas species, enteric redmouth disease, vibrio and bacterial kidney disease.

Third, no one may move finfish from one marine aquaculture site to another unless the new site is approved for that species and contains finfish that have the same disease profile.

Fourth, no one may move Atlantic salmon from one site to another unless the new site is within the same watershed and contains Atlantic salmon with the same disease profile.77

Interactions with Marine Mammals and Other Species

The *Marine Mammal Regulations*, adopted under the federal *Fisheries Act*, prohibit anyone from disturbing a marine mammal except under the authority of these regulations. Any attempt to kill a marine mammal must be made in a manner that is designed to kill it quickly.

Waste Discharges

The estimated site potential for a proposed salmon farm is determined assuming ideal conditions exist at the site and that no accumulations of feed and faeces will occur. A conservative approach is taken to test those assumptions in the initial years of production. Taking into account the characteristics of the seabed under the site, the initial production level is set at between 50% to 70% of maximum production and site monitoring is set up to demonstrate whether the site's approved level is actually the area's maximum sustainable level.

If, at any time, unacceptable environmental impacts are found, site management practices and physical parameters will be evaluated with the salmon farmer in an effort to correct practices that may be contributing to the site degradation. Failing satisfactory improvement, production levels may be frozen or reduced. If the situation permits, consideration may be given to expanding the site boundaries to allow for shifting of the net-cages within the site.

Increases in production levels and site boundaries will not be granted without an assessment of the marine environment's capacity to sustain the existing level of production. A salmon farmer applying for an increase in production or an expansion of the site boundaries must complete two full production cycles at the maximum authorized level. At the time of the application, the applicant must submit, at its own expense, the following information:

- a videotape and seabed survey designed to assess the organic sediment accumulation below the marine cages and the presence of gas;
- sediment sampling and analysis;
- a report on production; and
- any other environmental data which may be available or requested.78

Monitoring and Reporting

The initial stocking level of a site is usually 50% or 70% of the estimated site potential and any increases are conditional on site monitoring showing no evidence of site degradation. Likewise, any expansion of a site and any increases in stocking levels are conditional on there being no adverse effects as shown by monitoring data. Evidence of environmental degradation at a site may result in a reduction of the approved stocking level.

An inspector may enter and inspect aquaculture premises at any time, may require the production of records, accounts and other documents (not financial) and may require a licence holder to provide samples and carry out tests.79

In 1992, the New Brunswick Department of Environment completed a baseline study of 52 marine salmon-cage sites, collecting and analysing sea-floor sediments, biota, and oceanographic data. This data is used to identify criteria for assessing individual sites, to develop sampling protocol for site evaluations, and for site-specific recommendations for minimizing the effects of sedimentation.

Environmental Assessment

As noted above, the provincial Department of Fisheries and Agriculture requires pre-site evaluations of all site applications and boundary amendments to determine whether the area tends to be depositional, that is, containing fine, silty sediments, or erosional in nature and to identify any unique features. The site evaluations are coordinated by the Regional office of the Department of Fisheries and Aquaculture at the applicant's expense. The siting process, as discussed above, assesses the environmental capacity to sustain aquaculture development at a proposed site prior to the site being approved.

Preventative Measures

The Minister of Fisheries and Aquaculture may refuse to issue an aquaculture lease or an aquaculture occupation permit or may refuse to alter the boundaries of land under an existing lease or occupation permit where it would, in the Minister's opinion

- cause undue conflict with other fishery activities permitted under federal or provincial laws or with ecologically and environmentally sensitive areas;
- result in conflict with other resource users; or
- create unacceptable environmental risks.80

The Registrar of Aquaculture may refuse to issue, renew or amend an aquaculture licence if one of the three situations noted above exists.81

Also, as discussed above, once per month six times per year marine sites must have fish tested for prescribed diseases.

Public Participation in Decision-Making

All applications to lease an aquaculture site, to amend the boundaries of an existing site or for occupation permits are subject to public comment. However, applications for aquaculture licences are not subject to public comment. Comments on proposed leases or boundary changes are solicited in two ways:

- First, the applicant must provide information in the Site Development Plan about all upland properties within 100 metres of the proposed site. This includes a list of property owners' names and addresses. Letters are sent by the Department of Fisheries and Aquaculture to each landowner advising them of the general nature of the application and allowing a period of at least 30 days for filing comments.
- Second, the applicant must arrange to advertise notices in both official languages to appear twice in two local newspapers which are circulated in the area where the proposed aquaculture site is located. A person may submit written comments to the Minister within a time period that is specified in the notice.82

Enforcement

The Registrar may suspend or revoke an aquaculture licence if the terms and conditions of the licence or the provisions of the Act and regulations are not complied with, if the licence holder has made false statements, or if the licence holder forfeits the right to occupy the site. The Registrar also has the authority to suspend or revoke the licence if the licence holder does not show due diligence, to the satisfaction of the Registrar, in fulfilling the conditions of the licence or in complying with the Act and the regulations.83

Anyone conducting aquaculture without a valid licence is liable on summary conviction to a fine under the *Provincial Offenses Procedure Act*.

Anyone convicted of an offence under the *Aquaculture Act* or the regulations under it is not eligible to apply for an aquaculture licence for a three year period.

V. WASHINGTON

Description of Industry

There are 12 net-pen salmon aquaculture facilities currently permitted by the Department of Ecology to operate in Washington. There also are three other tribal facilities in operation.

All salmon farms are primarily farming Atlantic salmon in marine facilities. The average salmon farm has an annual production capacity of about 2,000,000 pounds.

Legislation and Administration

An applicant for a new salmon farm normally begins by contacting the local government's planning office. This office will provide advice about the necessary shoreline permits and the state environmental review process under the *State Environmental Policy Act*. The local government or county office also provides information to applicants about other agencies that must be contacted and other permits that are required. Applicants may use a Joint Aquatic Resource Permits Application to apply for Shoreline Management Permits, Hydraulic Project Approvals, Short-Term Modifications of Water Quality Standards, Water Quality Certifications for other federal permits, and Army Corps of Engineers Permits.84

When a new salmon farm is proposed, an application must be made under the *State Environmental Policy Act* and an environmental impact statement usually is required.

The county in which the salmon farm plans to operate is responsible for issuing a Shoreline Permit under the *Shoreline Management Act.* This Act is very comprehensive and addresses the public's right to visual and physical access to the shoreline and the natural character, resources and ecology of shorelines and water bodies. The state owns most aquatic lands, including tidelands, shorelands, harbour areas and the beds of navigable waters. Anyone using these lands or the waters above the lands for a salmon farm must obtain an aquatic lands net-pen lease from the Department of Natural Resources.

The Department of Ecology is responsible for issuing a National Pollutant Discharge Elimination System Waste Discharge Permit under the authority of the State of Washington *Water Pollution Control Law* and the federal *Clean Water Act.*

The Department of Fish and Wildlife is responsible for addressing the potential impact on migratory salmon. It administers the *Hydraulic Code*, which is designed to protect fish life and habitat. Work, construction, development or other activities that use, divert, obstruct or change the natural flow or bed of fresh or salt water of the State require a Hydraulic Project Approval, which is issued by the Department of Fish and Wildlife. It also is the department responsible for issuing permits to import or transfer live finfish or eggs.

The federal *Coastal Zone Management Act* requires that all projects in the coastal zone be certified by the Department of Ecology before a federal agency such as the Corps of Engineers grants its permits. Certification occurs after a public comment period. This certification ensures that federally permitted projects are consistent with the state Coastal Zone Management Program, which has federal approval. This applies to all shoreline activities in or affecting Washington's 15 coastal counties.

Other federal permits may be required to deal with matters such as navigational concerns, depending on the location of the proposed salmon farm. The *Federal Rivers and Harbors Act* regulates work in or affecting navigable waters. This Act has provisions aimed at ensuring public safety, public access to surface waters and other navigation issues.

Siting

When the county receives an application for a Shoreline Permit it will review the application to determine whether it is in one of the areas designated by the county as permitting or prohibiting aquaculture or some category of aquaculture, such as finfish farming.

A Shoreline Permit is required for work or activities within the 100-year floodplain or within 200 feet of the Ordinary High Water Mark of certain waters if the fair market value of the project equals or exceeds $2,500 or if it materially interferes with normal public use of the waters.
An application under the *State Environmental Policy Act* is subject to a programmatic environmental impact statement which includes guidelines for siting that address issues such as habitats of special significance.
The county routes the application to state agencies that have jurisdiction over salmon farming matters, including the Department of Natural Resources, which has authority to issue an aquatic lands net-pen lease using siting guidelines.

Operating Licence

Salmon farmers must register with the Department of Fish and Wildlife as an aquatic farm, listing annual production rate.

Escaped Farmed Fish

State law prohibits the release of wildlife, including farmed Atlantic salmon, into the natural environment.

Disease

The state *Aquaculture Disease Control Act*85 requires the directors of agriculture and fisheries to develop a program of disease inspection and control for aquatic farmers to protect the aquaculture industry and wildstock fisheries from a loss of productivity due to aquatic diseases or infestations of parasites or pests. The disease program may include the following elements:

- disease diagnosis;• import and transfer requirements;• provision for certification of stocks;• classification of diseases by severity;• provision for containment and eradication of high-risk diseases;
- provision for destruction or quarantine of diseased cultured aquatic products;
- provision for coordination with state and federal agencies;
- provision for development of preventative or control measures;
- provision for cooperative consultation service to aquatic farmers; and
- provision for disease history records.

The Act requires the directors of agriculture and fisheries to adopt a schedule of user fees for the disease inspection and control program with the aim of having the program entirely funded by revenues from the user fees.
The Act further provides that all aquatic farmers must register with the Department of Fish and Wildlife and sets the framework for collecting statistical data from farmers and forwarding it to the state veterinarian.

Therapeutants

There are disease control chemical use requirements included in the National Pollutant Discharge Elimination System Waste Discharge Permit. These requirements apply to drugs and chemicals included in feed or administered by bath or dip treatment where those materials could be discharged into state waters.
For instance, all disease control drug and chemical use must be done in conformance with product label instructions, approved Investigational New Animal Drugs protocols, or be administered by or under the supervision of a licensed veterinarian. Drugs that are not used under label instructions or under the approved protocols noted above must be administered by or under the supervision of a licensed veterinarian and be approved in advance by the Department of Ecology.
The National Pollutant Discharge Elimination System Waste Discharge Permit requires a permit holder to report the use of any disease control chemicals annually unless the Department of Ecology requests the information on a more frequent basis.

The National Pollutant Discharge Elimination System Waste Discharge Permit also provides that the Department of Ecology must require sediment antibiotic resistance monitoring if it determines that a permitted discharge poses a threat to human health or the environment. The basis for requiring this monitoring may be, but is not limited to, the following:

- new information on the environmental impacts of antibiotics; or• abnormally high usage levels of antibiotics by the permit holder.

Transport of Fish

The *Aquaculture Disease Control Rule*,86 adopted under the authority of the Act, sets requirements for importing and transporting finfish. To import or transfer live fin fish or eggs, a salmon farmer must obtain a Finfish Import/Transfer Permit which is issued by the Department of Fish and Wildlife. A copy of the permit must accompany the fish at all times within the state. The director has the authority to impose permit conditions to protect farmed salmon and native finfish from disease when the director concludes there is a reasonable risk of disease transmission associated with the finfish aquaculture products.

This Rule also requires that the Department of Fish and Wildlife be notified by the end of the following working day if an accredited pathologist confirms the diagnosis of any of the following:

- viral hemorrhagic septicemia;• whirling disease;• infectious hematopoietic necrosis; or• infectious pancreatic necrosis.

The notification for the latter three applies only where the diagnosis occurs in a previously uninfected lot.

The application for a permit to import or transfer live finfish or eggs requires information on

- species,• the state of origin,• details about transport equipment and procedures,• the disease history of the stock, the shipping facility and the watershed of origin, and• the last disease inspection.

The Department prefers five years of disease history of the fish and the fry at the site of origin to determine on a case-by-case basis if the fish can be transported.

The state adopted a more detailed policy87 relating to the import or transfer of cultured aquatic products under the *Aquaculture Disease Control Rule*. It provides that, except for eyed eggs and sperm from inspected male broodstock, live fish, eggs, or gametes of any salmonid will not be imported into Washington State from outside North America. It also sets requirements for importing eyed eggs and eggs fertilized with imported sperm. Most commercial broodstock are now locally raised.

Interactions with Marine Mammals and Other Species

The siting guidelines recommend net-pens be located more than 1,500 feet from bird and mammalian habitats of special significance including seal and sea lion haulout areas, seabird nesting sites or colonies, and areas identified as critical for feeding or migration of birds or mammals.

If a salmon farm is located in an area frequented by marine mammals, a salmon farm operator may obtain an Exemption under the Marine Mammal Protection Act allowing the operator to keep marine mammals from preying on farmed salmon.

The Department of Fish and Wildlife requires a Hydraulic Project Approval for any work done in or over the ordinary high water mark of the State and, in issuing an Approval, reviews the proposal for potential impacts on all fish life.

Waste Discharges

The federal *Clean Water Act*88 established water quality goals for the navigable waters of the United States. One of the mechanisms for achieving the goals of the *Clean Water Act* is the National Pollution Discharge Elimination System of permits which is administered by the Environmental Protection Agency. The latter agency has delegated responsibility to administer the National Pollution Discharge Elimination System permit program to the state of Washington.

The regulations adopted by the state include procedures for:

- issuing permits,89• water quality criteria for surface waters, ground waters and sediments,90 and• technology based standards.91

The regulations also establish the basis for effluent limitations and other requirements included in the permit. Included in these regulations are the following new rules applying to marine finfish rearing facilities or marine salmon net-pens which were adopted by the Department of Ecology to meet a state legislative direction:

- Wastewater Discharge Standards and Effluent Limitation set October, 1995, and• Sediment Management Standards set December, 1995.92

After the rules were set, each of the existing facilities was required to apply for a National Pollutant Discharge Elimination System Waste Discharge Permit by January 31, 1996. Permits were issued to all 12 facilities on September 18, 1996. Each of these permits is now under appeal but the permits remain in effect during the appeal process.

A National Pollutant Discharge Elimination System Waste Discharge Permit, issued by the Department of Ecology, incorporates waste discharge standards, sediment standards and water quality standards. It is issued for a five-year period.

The waste discharge standards set the threshold for requiring a National Pollutant Discharge Elimination System Waste Discharge Permit as one or more of the following:

- annual production of over 20,000 net pounds of finfish; or• feed consumption of over 5,000 pounds per calendar month; or• fish farm is designated as a significant contributor of pollution by the department.

The waste discharge standards provide that all wastes and other materials and substances discharged must be provided with all known, available and reasonable methods of treatment prior to entry into the water, with more stringent site specific requirements if there is a reasonable potential to exceed the water quality standards.

The permits specify detailed requirements for each salmon farm, based on the requirements of the Wastewater Discharge Standards and Effluent Limitations and the Sediment Management Standards. The permits contain both specific and general conditions. The specific conditions include:

- effluent limitations;• monitoring requirements;• reporting and record keeping requirements;• operating requirements; and• requirements for preparing a pollution prevention plan.

The operating requirements include a number of detailed provisions, including the following:

- corrective action much to taken immediately to correct non-compliance with the permit and can include a reduction in feeding rate or removal of fish from net-pens;
- fish feed must be administered to maximize ingestion by the reared fish;
- fish carcasses must be removed from net-pens on a frequent basis and collected and stored in leak-proof containers;
- fish mortalities, harvest blood and leachate from these materials must be stored and disposed of in a way that prevents them from entering state waters;
- accumulated solids and attached marine growth within or on the net-pen must be disposed of in a manner that prevents the materials from entering state waters, to the maximum extent practical;
- chemicals, petroleum products and potentially toxic substances must be kept to a minimum and stored in leak proof storage areas;
- the permit holder must not discharge sanitary waste;
- the permit holder must not use or discharge toxic chemicals to control the fouling of nets; and
- the permit holder must recover floating debris and trash.

Monitoring and Reporting

The Wastewater Discharge Standards and Effluent Limitation sets out that a permit must require monitoring and reporting to ensure compliance with state water quality standards and sediment management standards to determine if a salmon farming is causing an impact. The monitoring system sets up a surrogate measure for determining impact and requires action if an impact is detected.

The Sediment Management Standards provide monitoring requirements be addressed through a National Pollutant Discharge Elimination System Permit as follows:

- new facilities must identify baseline sediment quality, prior to operation, for benthic infaunal abundance, total organic carbon and grain size in the proposed location and downcurrent areas that may be affected;
- existing facilities must monitor sediment quality for total organic carbon (TOC) levels and identify the location of sediments in the area of the facility that differ from baseline levels or the total organic carbon levels set out in the standard;
- locations and frequency of monitoring are to be set out in the National Pollutant Discharge Elimination System permit;
- antibacterial monitoring is to be established on a case-by-case basis;
- if the sediment quality conditions are not met beyond 100 feet from the facility, outside the sediment impact zone, an enhanced sediment quality monitoring program must be undertaken, including testing for benthic infaunal abundance.

Environmental Assessment

An initial application for a new salmon farm is made under the *State Environmental Policy Act.* The Act is intended to identify and disclose the environmental effects of a proposed project. The applicant must provide information to satisfy the provisions listed in the *Final Programmatic Environmental Impact Statement for Fish Culture in Floating* Net-Pens, which sets general industry requirements as well as any additional site-specific information about location, such as site characteristics and data on water currents.

The application triggers a public review. The local government sends notices of the proposal to appropriate individuals, citizen groups, tribes and state, local and federal agencies. Following the public review period a final environmental impact statement is produced which forms the basis for applications to other agencies.

The state environmental review process must be completed before state and local permits will be issued.93

Preventative Measures

Each of the waste discharge permits issued to all marine finfish rearing facilities require the permit holder to prepare a pollution prevention plan within six months of the waste discharge permit being issued. The pollution prevention plan must specify operating practices which do not violate other conditions of the permit and which prevent or minimize the release of pollutants from the facility into state waters. The permit states that the permit holder must operate the facility in compliance with this plan along with any subsequent amendments or revisions.

Overall the pollution prevention plan must address operating procedures, spill prevention, spill response, solid waste, and storm water discharge. The specific issues which the permit states must be addressed in the plan are:

- how fish feeding will be conducted to minimize the discharge of unconsumed food;
- how net cleaning will be conducted to minimize the discharge of accumulated solids and attached marine growth;
- how disease control chemicals are used to ensure the amounts and frequency of applications are the minimum necessary for effective disease treatment and control;
- practices for storage and disposal of disease control chemicals;
- how solid and biological wastes, including fish mortalities and blood from harvesting, are collected, stored and disposed;
- procedures to prevent or respond to spills and unplanned discharges of oil and hazardous materials, including
  - the reporting system to alert management and the authorities,
  - a description of facilities to prevent, control or treat spills and unplanned discharges with a schedule for installing any necessary facilities,
  - spill

response procedures and equipment, and• a list of all hazardous materials used, processed or stored at the facility; and

- procedures to identify and prevent existing and potential sources of stormwater pollution.

The permit requires the operations staff at the facility to be familiar with the pollution prevention plan and adequately trained in the specific procedures which the plan requires.

In general, wastes and other materials are not allowed to enter state waters if it will reduce existing water quality, except in situations where it is clear that overriding considerations of the public interest will be served by allowing this to occur.

Public Participation in Decision-Making

There is provision for public review during the application process under the *State Environmental Policy Act* (SEPA).

During the rule-making process for developing the waste discharge and sediment rules, three public workshop hearings were held to receive formal public comments. When the National Pollutant Discharge Elimination System Waste Discharge Permits were available in draft form, public announcements were made in newspapers and three public hearings were held, dealing with all of the 12 permits at the same time. The Department of Ecology issued a document responding to the public comments. The Permits were issued and notice sent to all interest parties. There is a provision that any interested party can appeal a Permit within 30 days of it being issued. The Permits are now under appeal.

VI. ALASKA

Legislation and Administration

In May, 1987, the Alaska legislature passed a bill placing a moratorium on issuing permits for salmon farming in open waters. In 1990, the Alaska legislature specifically prohibited finfish farming in the *Fish And Game Act* by providing that "a person may not grow or cultivate finfish in captivity or under positive control for commercial purposes."

The Act states that this section does not restrict state fishery rehabilitation, enhancement, or development activities. It does not restrict the ability of a nonprofit corporation that holds a salmon hatchery permit to sell salmon returning from the natural water of the state.

"Salmon Ranching"

1974 Alaska legislation allows the Department of Fish and Game to issue permits to nonprofit corporations to run salmon hatchery programs where salmon are raised and released. Until the salmon return to either the hatchery or alternate release site, they form part of the public fishery. Regulations allow a Hatchery Special Harvest Area to be established at either the hatchery or alternate release site and, in that area, the hatchery is allowed to catch returned salmon and sell them to recover cost of running the hatchery. The regulation setting up the Hatchery Special Harvest Area can provide that the area is closed to all other fishers or can allow it to remain open to sport fishers. Most organizations that have established operations are associations of fishers. Nonprofit corporations are permitted to recover only their costs, so there are limits on the amount they can harvest.

Since Alaska does not have a salmon aquaculture industry that is comparable to the industry in British Columbia and the other jurisdictions discussed in this report, the points of comparison used throughout the remainder of this report for each of the other jurisdictions will not be discussed in connection with Alaska.

VII. CHILE

Description of Industry

Chile is the second largest producer of farmed salmon in the world. In 1995, the gross production of farmed salmon and trout was approximately 141,000 tons, following a period of rapid growth in recent years from a combined production level of 8,600 tons ten years ago.94 The primary species raised are Atlantic salmon, coho salmon and sea rainbow trout, in that order.95

The entire aquaculture industry has experienced explosive growth over the past decade with farmed salmon representing the largest percentage of the total volume. Several conditions have been identified as contributing to the rapid growth of the industry, including

- extensive coastal areas, lakes and rivers providing favourable environmental conditions for farming,
- a non-polluted, viral disease-free environment,
- long hours of sunlight during the winter,
- economic policies encouraging exports,
- low cost labour, and
- the availability of feed inputs such as high quality fishmeal.96

Currently, there are approximately 90 companies operating salmon and trout farms in Chile, with approximately 361 farming concessions (leases) authorized by the fishing and maritime authorities. There are approximately 100 pending resolutions that have not been authorized yet by the authorities. There are 185 authorized (licensed) fish farms, approximately 80 of which are operating. The farms cover an area of approximately 4,700 hectares.97

The main markets for Chilean farmed salmon are Japan and the United States. As elsewhere, the price of farmed salmon and trout raised in Chile has declined sharply over the past three years.

The *1997 Compendium of Chilean Aquaculture* states that Chile has made considerable efforts in environmental matters to reach the level of countries with greater development. However, it also states that there is still much to be done in this regard and significant challenges for the future.

Legislation and Administration

The *General Law of Fisheries and Aquaculture* was enacted in September, 1991. It provides the legal framework to regulate the development of the fishing industry in Chile and contains a series of provisions which are included in one legal text. The *General Law of Fisheries and Aquaculture* provides the authority to issue regulations to complement the general provisions in the Law and fill in gaps in some of the provisions.98

Some of the regulations under the Act have been brought into force and others are still under development. Those in effect deal with

- granting concessions (leases) and authorizations (licences),
- setting up a national registry of aquaculture operations,
- establishing the number and size of the cultivation structures,
- outlining the procedures for importing aquaculture species,
- setting requirements for certifying imported species are disease free, and
- approving the importation of species for the first time.99

The *Regulations on Environmental Protection* for fish farming are still under development.

There were, of course, salmon farms established under laws in effect prior to the date when the new Act was brought into force. Apparently, there have been a number of problems in dealing with applications for salmon farm approvals which began prior to the change in the law in 1991, resulting in significant delays in processing applications.100

Siting

In relation to siting, conflicts have been most frequent between aquaculture and tourism, small scale fishing interests and other users of rivers, lakes and coastal areas. Conflicts often relate to incoming and outgoing traffic in the channels of ports and bays, maritime safety issues, use of harbour areas and protection of wildlife zones.
A process called Determining Areas Suitable for Aquaculture was established to allow the development of the industry while taking into account environmental concerns and other conflicting interests. The purpose of the process was to determine Areas Suitable for Aquaculture for each Region in Chile. Commissions were set up in each Region with representation from interests proposing other uses for the areas. After the opinions of the various sectors were heard, the maritime and fishing authorities made the final decisions by enacting Executive Decrees of the Ministry of Defense (Marine Undersecretariat) for some of the Regions. These Executive Decrees determine the establishment of Areas Suitable for Aquaculture for coastal marine zones and are issued in response to a Resolution of the Undersecretariat for Fisheries.
The final Decrees are in place in only six Regions of the country. At the end of 1995 there were three coastal Regions where Resolutions had been issued by the Undersecretariat for Fisheries, but Decrees determining the Areas Suitable for Aquaculture had not been enacted due to objections and modifications by the Admiralty.
In addition, during 1995 there was no clear policy setting out the criteria for the future use of lakes and rivers for the development of salmon farming. This is considered to be a significant problem to the industry.
A salmon farmer must apply for a concession to operate a farm, a form of tenure similar to a lease or licence of occupation. The Undersecretary for Marine Affairs, with the recommendation of the Undersecretary of Fisheries, approves the aquaculture concession. The concession is actually granted by the Ministry of National Defense. The Regulation of Aquaculture Concessions and

Authorizations101 regulates the procedures, necessary data and requirements for applying for aquaculture concessions and authorizations, transfers, rentals and expirations. A concession is granted for an indefinite period of time and can be transferred, leased and sold.

Operating Licence

In an area that is specified as appropriate for aquaculture, an authorization from the Undersecretary of Fisheries is required to develop an aquaculture facility. An authorization is an aquaculture licence based on an operating plan for a particular species on a site.102
An aquaculture authorization will specify the types of species that may be raised on the fish farm.
Both the concession and authorization are subject to the provisions of the *General Law of Fisheries and Aquaculture* and its regulations.
When a salmon farmer receives an aquaculture concession or authorization, the farmer is required to register it with the national aquaculture registry kept by the National Fisheries Service before beginning operations.

Escaped Farmed Fish

The *1997 Compendium of Chilean Aquaculture* refers to problems related to farmed fish escaping, such as the potential impact of the new fish diseases and the possible alteration of native trophic structures. However, there does not appear to be any regulatory mechanism in effect to deal with preventing escapes.

Disease, Therapeutants and Transport of Fish

Chile relies to a significant degree on importing eggs for salmon farming.
The *Regulations for Health Certificates for Importing Hydrobiological Species* establish the requirement that imported species must be certified by an official authority in the country of origin to be free of the diseases which are listed in the regulation. The regulation identifies different diseases for different species of fish.103
A regulation is also in effect dealing with the importation of exotic species104 where the species are new to Chile. It is designed to reduce the risks associated with the introduction of exotic species. It contains general provisions for importing species for the first time, conditions and technical terms of reference for the health examinations on

imports, and requirements for the facilities conducting the examinations. The regulation also identifies the data about the species and their biological cycles that is required if they are to be imported.

Interactions with Marine Mammals and Other Species

There do not appear to be any specific regulatory mechanisms dealing with the potential impacts of salmon farms on marine mammals and other species.

Waste Discharges

The *General Law of Fisheries and Aquaculture* provides the authority to develop regulations for environmental protection to ensure that salmon farms operate at levels that are within the capacities of the marine areas in which they are located. These regulations have not been completed.

Environmental Assessment

In 1994, a new General Environmental Law was passed creating a framework for environmental laws and articulating the principle of environmentally sustainable economic development. This law establishes the basis for an environmental assessment process requiring new projects to go through an environmental assessment if the project is above a specific threshold level. The thresholds have not yet been set. A proponent can avoid an environmental assessment by signing a declaration indicating the project will have no environmental impact and accepting responsibility for impacts if they occur.105

Preventative Measures

The *1997 Compendium of Chilean Aquaculture* makes reference to the need to maintain a degree of environmental protection, in part due to trade relations. It points out that the development of production systems which minimize or eliminate pollution levels are of paramount importance.

Public Participation in Decision-Making

In determining the areas appropriate for aquaculture, including salmon farming, the *General Law of Fisheries and Aquaculture* requires technical studies to be completed as well as consultation with

> "entities in charge of alternative uses of those lands or waters, especially considering the existence of hydrobiological resources or conditions for their production and environmental protection. Non-industrial extractive fishing activities will also be considered, as well as their communities, the channels to enter and leave ports and coves, areas where the Chilean fleet anchors and carries out naval operations, port areas, aspects of tourist interest and protected areas which include National Parks, Reserves and Monuments."106

When the areas appropriate for aquaculture have been determined, the Act requires public notification in the Official Gazette and a local newspaper. Any private party or organization that is affected may express its written opinion within 30 days. The Undersecretariat is supposed to reply to the interested parties within 60 days.

Enforcement

The *General Law of Fisheries and Aquaculture* provides for fines when the Act is violated. The fines are calculated by multiplying the value of the penalty by the total amount of species on the site, either dead or alive, and multiplying it by three or four. The manager or administrator of the salmon farm also can be penalized personally.107

VIII. IMPLICATIONS AND TRENDS RELEVANT TO BRITISH COLUMBIA

The regulatory and management framework in each of the jurisdictions reviewed developed in response to the challenges posed by salmon aquaculture. There are a number of similar themes in the issues and approaches taken, including:

- the complexity of the regulatory framework;
- regulatory authority residing in a number of different agencies;
- the rapid growth of the salmon aquaculture industry prior to the full development of the regulatory framework, resulting in regulations and other measures often being developed in response to problems which had already occurred rather than to anticipate and prevent problems;
- the increased use of environmental quality standards or ambient standards to determine whether or not an impact is occurring;
- limited resources for monitoring for environmental impact or compliance with regulatory standards;
- siting guidelines or regulations designed to address concerns that are similar in many locations; and
- regulations or procedures that were developed to address common environmental concerns in relation to the spread of disease, the use of therapeutants and other chemicals, the impact of farmed fish on wild stocks, and waste discharges.

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SALMON AQUACULTURE REVIEW

OVERVIEW OF EXISTING AND DEVELOPING TECHNOLOGIES FOR COMMERCIAL SALMON CULTURE

REPORT

PART D

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PART D—TABLE OF CONTENTS

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BACKGROUND

Members of the public and some Review Committee members for the Salmon Aquaculture Review have consistently expressed a desire for the recommendations of the Environmental Assessment Office to either strictly regulate the technology employed in commercial salmon culture (e.g., allow only the use of land-based or closed systems) or to set stringent performance standards (e.g., zero discharge into the environment). The salmon aquaculture industry has expressed a concern over their ability to meet some suggested performance standards or employ certain technologies. In order for the Environmental Assessment Office to fairly and comprehensively consider all recommendations brought forward throughout the Review process, it is important that a broad overview and assessment of the general state and availability of technologies which are alternatives to today's dominant use of floating marine net-cages in British Columbia be available.

The purpose of this report is to provide a general assessment of other existing and developing marine or saltwater salmon aquaculture technologies which may be applied on a commercial grow-out basis. These technologies can be categorized as follows:

- exposed offshore open marine systems• closed circulating marine systems• land-based saltwater systems

For each category the Salmon Aquaculture Review will require an assessment of (i) the current state and technical feasibility of the technologies, (ii) the direct environmental and potential social implications for the employment of the technologies, and (iii), the economic feasibility of employing the technologies. Technologies which can be considered 'minor' modifications to the floating marine net-cage used in British Columbia today or modifications to aquaculture methodologies will not be reviewed here. Similarly, technologies which have only been applied in freshwater systems or for smolt production are not discussed. For further direction into the types of techniques which may be applied to avoid or mitigate the potential and realized deleterious environmental, economic and social impacts resulting from salmon aquaculture, the reader is referred to the discussion of the major findings and recommendations of the Technical Advisory Team for the Salmon Aquaculture Review, and the main report of the Environmental Assessment Office provided in a separate documents.

The short time window available for the completion of this project necessitated some limitations. The report relies on information available from current practical experience. This involved a review of the literature and contacts with involved companies, governments, and organizations worldwide. In many cases, an independent verification or audit of the information provided was not possible. This report relied on the experience and expertise of those working in the field and providing industry services. The direct environmental implications for the employment of the technologies was tightly linked and extrapolated from the results of the review, but did not involve primary data collection or detailed analyses. Similarly, a detailed economic analysis of alternative technologies was not possible. A general assessment is provided for each technology based on expected limiting factors and the worldwide experience. All tasks focused on providing a broad overview of the issues and outlining the general themes. A more detailed process design and cost estimate for a land-based salmon rearing facility in B.C. was conducted by Simons Environmental of Vancouver, B.C. The report is appended.

INTRODUCTION

Commercial aquaculture operations primarily depend on the physical technologies associated with the containment of the fish and the attached structures, and the biotechnologies employed (Rosenthal *et al*., 1995). This document will address the current use and emergence of physical technologies which are alternatives to traditional floating marine net-cage use (Figure 1) for commercial salmon grow-out. For discussion, the alternative technologies have been categorized into three main areas to which they apply: (i) exposed offshore open marine systems, (ii) closed circulating marine systems, and (iii) land-based saltwater systems. For each, technical design and feasibility, siting requirements, as well as environmental and economic advantages and disadvantages, will be outlined. Examples will be used to illustrate where appropriate.

The primary reasons for exploring the availability and use of alternative technologies are the desire to control environmental impacts, the desire to improve efficiencies in culture methods, and the desire to augment the limited number of coastal sites appropriate using traditional marine net-cage systems (Karlsen, 1993). Environmental concerns include both those which may impact the cultured fish (e.g., poor water quality, exposure to pathogens and harmful plankton blooms) and those which may impact the surrounding ecosystems and affect the use of the environment (e.g., benthic smothering, antibiotic release). Rosenthal *et al*. (1995) identifies five technology-related phenomena in aquaculture which are driving current research: (i) a trend towards intensification of land-based systems, (ii) specialized production in established, conventional systems using improved technologies, (iii) concern over possible environmental consequences, (iv) the impact of natural environmental conditions on aquaculture operations, and (v) the need for business and market oriented production schemes. All of these apply, at least to some extent, to salmon aquaculture trends worldwide. These five themes will emerge throughout this document.

Figure 1. Typical floating marine net-cage design in use throughout coastal British Columbia.

EXPOSED OFFSHORE OPEN MARINE SYSTEMS

Traditional floating marine net-cage systems have the advantage of being easy to operate, requiring a relatively low capital investment, relying on simple yet proven technology, and allowing for easy incremental changes in production capacity (Karlsen, 1993). Modifications to the open marine system design in order to operate in more exposed locations may assist in addressing some environmental and coastal siting issues, improve production efficiencies, and open up alternative sites for farming, yet maintain some of the benefits of the traditional commercial culture methods. The extent to which this can be realized, however, is dependent on the nature of the technology which is required to move to a harsher environment and the location in which it is used. Constraints or benefits are dependent on the particulars of the system employed.

A few words of clarification must be made regarding what is meant by an "offshore system". This is taken to mean locations which are exposed to harsher environmental conditions, specifically large waves or swells and potentially high currents, than is currently the case for most sites being used by the B.C. salmon farming industry. It is the production benefits of growing fish in a consistent, higher quality water source with greater flushing rates than is found in more sheltered locations that is primarily driving the move to offshore. "Offshore", then, can mean a few hundred metres from the shore, or a few hundred kilometres. A cross-sectional description of the primary types of systems that are available for exposed offshore use is outlined below.

SYSTEM DESIGN AND TECHNICAL FEASIBILITY

The traditional gravity or floating net-cage system cannot be placed in exposed, offshore locations due to limits in structural strength and endurance, operation limitations, and worker safety (Karlsen, 1993; Loverich, 1996; Loverich and Swanson, 1993). Floating net-cage structures are susceptible to deformation and collapse of the nets in the face of strong currents, and, being 'tied' to the surface through their floating surface structure, are maximally subject to wave forces and thus subject to structural fatigue (Loverich and Gace, 1997; Loverich and Swanson, 1993). Break-up and loss of stock can result. The tension, compression, and torsion loads which must often be endured in an exposed coastal environment are considerable-over a ten-year design service life, greater fatigue life is required than for a Boeing 747 for landing and pressurization/depressurization cycles (Willinsky and Huguenin, 1996).

The primary engineering and operational challenges that have been faced in practical trials of offshore systems include (i) hardware failure and insufficiencies in design, (ii) lack of focus and function in the team of workers, and (iii) difficult logistics associated with an isolated and exposed location (Loverich and Swanson, 1993; Willinsky and Huguenin, 1996). The difference in the day to day operations in a facility offshore from that of a sheltered coastal environment means that the crews must be experienced and skilled mariners and that operation methods must be specific to that environment (Loverich and Swanson, 1993). It is imperative that operating and service functions (e.g., stocking, feeding, inventory and grading, monitoring, stock treatment, harvesting, mechanical maintenance, biofouling control) be taken into account before cage designs are fixed and technologies adopted (Willinsky and Huguenin, 1996). The tailoring of operations to fit the harsher environment may result in significant modifications to the methods applied to salmon aquaculture in sheltered coastal areas.

Floating breakwaters can be used as a first line of defense to damper the effects of waves on aquaculture cages in exposed coastal areas. There are two primary types used throughout the world: the Bridgestone breakwater (floating synthetic rubber-filled fibreglass modules) and the Kowalski or Goodyear floating tire breakwater (tires tied together and positioned vertically in the water to form a module; Beveridge, 1996). Use of a breakwater, however, may not be generally feasible or effective at large distances from the coastline. Also, they are expected to be of limited utility under severe storm and wave height conditions.

Developments of offshore finfish aquaculture operations have included surface and submersible cages with both fixed and flexible moorings (McVey, 1996). More specifically, bottom mounted (submerged cages and barrier systems), surface operated but bottom moored (nested cages, large single cages, or fully submersible cages), and

surface operated, moored and flexible systems (barge or ship systems) have been developed (Willinsky and Huguenin, 1996). It is perhaps most useful to view the development of technologies suitable for use in offshore locations as a continuum of adjustments to the traditional floating net-cage structure used in sheltered locations which enable the system to be used effectively in harsher environments. At the one end we find adjustments to the supporting surface floating structure which make it more flexible, while with more novel engineering we find a complete abandonment of the floating design in favour of systems which avoid surface tensions and compressions.

The fish cultured using offshore systems include salmonids, yellowtail, seabream, tuna, and flatfish. Only those designs which can be specifically applied to salmon culture will be discussed here. As there are numerous designers and suppliers of offshore farming systems throughout the world, the following is a representative cross-section of the types currently in use and those which perhaps are most promising.

Examples of Systems Developed

AquaSure Cage

AquaSure is a manufacturer of 'PolarCirkel-type' cages and are supplied locally and used on the British Columbian coast (Mike Mulholland, pers. comm.). In order to endure the harsher conditions of more exposed locations, the design focuses on maintaining flexibility in the floating supporting structure. Other than this design feature, it differs little from the traditional floating net-cage structure used on this coast. In fact, the local supplier of this system does not consider it to be an 'alternative technology' (Mike Mulholland, pers. comm.). The dominant use of a net-cage with a rigid floating structure which is only suitable for sheltered locals may be more of an 'accident of history' than required due to cost and siting restrictions (i.e., that is the system which was first used on the coast and there was no perceived need to abandon its use).

The circular design of the AquaSure cage consists of two floatation polyethylene pipes enclosed by a one piece rotationally molded stanchion that also supports the handrail. The company has experienced no system failures with over 500 cages being used over a 10 year period. Over 300 cages are being used for salmon farming, with others being used for the culture of tuna, trout, seabream, and baramundi. 15 cages are currently operating commercially in B.C., and 11 in Washington state. Up to a 50 m diameter cage is available for salmon culture, but a 70 m diameter design is currently under development. A 30 m cage can be purchased for about $24,000. The AquaSure circles are designed to withstand waves up to 8 m.

Bridgestone Hi-Seas Cage

The Japanese company Bridgestone manufactures floating net-cages with a flexible rubber support collar to withstand exposed marine conditions. The company advertises that it is the oldest and most successful developer of offshore fish cages (Gunnarsson, 1996). The first commercial unit was installed in Japan in 1983 and in Europe in 1984. To date, over 300 units have been sold worldwide with no major design changes. It is presently being used for the commercial culture of salmon, yellowtail, seabream, and tuna (Gunnarsson, pers. comm.). Most operations are operating profitably, although some producers in the past have gone bankrupt usually due to factors other than equipment. All cages from bankrupt operations have been purchased by other companies and are still in use (Gunnarsson, pers. comm.).

The flexible floating single-string rubber hose collar has no moving parts, and with the net and moorings are known to withstand typhoon conditions with wave heights of up to 10 m (Gunnarsson, per. comm.). The central philosophy behind the net design is that the frame's only function is to hold the shape of the net, not to act as a working platform or support other service functions (Gunnarsson, 1996). This keeps the design simple, yet functional. Nets fastened to but not hung from the collar; they are self-supporting using purse-seine floats. Because they are intended to withstand the same primary environmental forces as the collar, nets are specially designed to absorb wave action and are reported to maintain their shape. The cages can be square, octagonal, or hexagonal with standard side lengths of 16 or 20 m, up to circumference of 160 m and 2,000 m^2, with nets 15 to 40 m deep. A 16 m octagonal 20 m deep cage has a volume of 25,000 m^3 and a production capacity of at least

500 MT (Gunnarsson, 1996). Prices for cage systems (frame, nets and moorings) start at US$150,000 (Gunnarsson, pers. comm.). Recommended stocking densities are 12-20 kg/m^3, with a maximum of 30 kg/m^3 recorded depending on the species cultured. Access to deep water (greater than 25 m) and proximity to a service harbour (recommend within half an hour motor vessel steaming time) are the only specific siting requirements. There are usually no working platforms or structures associated with the cages on site. The company maintains that there are now a suitable selection of equipment and methodologies available for use with a large offshore cage (e.g., service vessels and platforms, feeding systems, mort collection) that operations and maintenance are relatively easy to carry-out (Gunnarsson, 1996).

Dunlop Tempest Cages

Dunlop also manufactures floating net-cages with a flexible collar support, similar to the Bridgestone cages. The Tempest 1 cage is composed of two concentric rings of flexible rubber hoses (Brittain, 1996). The hoses serve as the main structural system for support of the net and service walkway. To reduce costs, this circular double-ring hose design has been recently superseded by square and polygon designs which have only a single rubber hose collar support (Dave Mallinson, pers. comm.). These more recent designs do not have a service walkway, but do have substantial corner platforms. The Tempest 2 cage is square and modular in design such that cages can be added to the raft as needed. Larger hexagonal (Tempest 3) and octagonal (Tempest 4) cages have been developed recently (Brittain, 1996). The cages have been used in Scotland, Ireland, the Faroe Islands, and Norway for salmon production (Dave Mallinson, pers. com.). The cages are also used in the Mediterranean for bass and seabream. There are currently approximately 80 cages being used today throughout the world. The largest cages sold for the production of salmon are 16 m sided octagonal with a surface area of 1,235 m^2, and are currently being used off the west coast of Ireland. Operations and production techniques are essentially the same as those for traditional floating marine net-cages. As with the Bridgestone cages, with little working platforms or structures associated with the cages on site, a suitable selection of equipment and methodologies must be used. The flexibility of the rubber structure makes it resistant to fatigue and the destructive forces of wave action, and sites to date have reported little need for structural maintenance (Brittain, 1996). The main advantage afforded by this system, as with the Bridgestone cages, is the flexibility and resilience of the rubber hose supporting structure in the face of rough weather, waves, and storm surges. The cages have been in use under rough sea conditions with up to 10 m wave heights and relatively short wave periods (Dave Mallinson, pers. com.). A recently supplied cage was designed to withstand up to 14 m wave heights on site. There is no need for use of predator nets with the larger cages, and farmers appear to experience little problem with aquatic mammals.

Ocean Spar Cages and Sea Station

The design philosophy of Ocean Spar Technologies, LLC of Bainbridge, Washington is that the forces of waves, current and winds must be avoided in sea cage design in order to avoid extreme deformation and to achieve durable cage structures in exposed locations (Loverich and Gace, 1997; Gary Loverich and Langley Gace, pers. comm.). This is in contrast to the aim of the floating AquaSure, Bridgestone and Dunlop cages, which is to remain flexible to surface forces, rather than avoid them. The alternative designs proposed by Ocean Spar (Figure 2) utilizes anchored tension or an internal framework to maintain cage shape and volume, and a floating spar that is only minimally affected by surface waves to provide buoyancy. An additional feature of the cage design is enclosure on all sides, which permits the cages to be submerged.

The Ocean Spar Seacage system is based on a cubic net completely enclosed on all faces and supported in the water by four floating spar buoys (floating ‘fence posts’) that support each of the eight corners with rigging (Loverich and Goudey, 1996). The designs have been tested in offshore environments in Juan de Fuca Strait, Puget Sound, the Bay of Fundy, and the Gulf of Mexico (Loverich and Swanson, 1996). The most exposed test location was in the Juan de Fuca Strait, 24 km west of Port Angeles, Washington and 1.6 km offshore (Gary Loverich and Langley Gace, pers. comm.). This cage operated for 3.5 years and weathered a 50 year and a 100

year storm without damage or loss to stock. An escape event of salmon did occur when a troller collided with the cage.

Spar cages do not have walkways and therefore the structure and stock must be serviced from a boat (Loverich and Swanson, 1996). A programmable barge feeder is used to deliver feed to the stock (Gary Loverich and Langley Gace, pers. comm.). The siting of the cages is currently constrained by a maximum anchoring depth within access to divers (approximately 35 m), although greater depths are possible if the appropriate service support is available. It is estimated that up to 30,000 m^3 rearing volume could be accommodated with one cage (at 20 kg/m^3 such a cage would accommodate 600 MT of stock). The systems cost about US$5-22 /$m^3$ of enclosed volume, depending on size and site conditions. The cost range for its standard 6200 m^3 system is US$18-22 /$m^3$. Cost savings are realized with larger cages.

The cages withstand high current and extreme weather, owing to the spar buoys being very stable and unaffected by passing surface waves (Loverich and Goudey, 1996). The net is held taut, and retains about 90 % of its volume in currents up to 1.75 m/s (Gary Loverich and Langley Gace, pers. comm.). Since the structure is not stressed or distorted by environmental conditions, they are expected to be more durable than traditional cage designs (Loverich and Swanson, 1996) and maintain higher effective rearing densities than traditional floating cages (Gary Loverich and Langley Gace, pers. comm.). Cages can be totally submerged to avoid plankton blooms or in the face of particularly bad weather. Mortalities can be removed through a 3 m zipper. Although the technology has not been implemented to a significant extent, there has never been an incident of system break-up, successful predator attack or escape (Loverich *et al*., 1996; Alice Eriksen, pers. comm.). The taut design of the net under normal operation appears to be able to resist all predator attacks, including sea lions (Gary Loverich and Langley Gace, pers. comm.).

The company has begun exploring a Sea Station design which is based on a circular steel rim suspended from a single central floating spar (Loverich and Goudey, 1996; Gary Loverich and Langley Gace, pers. comm.). Radiating framing lines form an interior skeleton supporting taut netting. The typical cage has a 15 m central spar and a rim 89 m in circumference. The design can withstand waves of over 7 m and currents in excess of 1 m/s. The cage retains 90 % of its volume in high current areas. Its position is adjusted vertically in the water column by adjusting the air volume in the ballast. Feeding, operation and maintenance can be accomplished from the crow's nest located centrally on the top of the spar. Mortalities are removed, without entering the net, from a port in the bottom of the structure. Harvesting can be accomplished by pulling a harvest ring up the spar, inverting the net, and crowding the fish for pumping through zippered ports; alternatively, a passive harvest can also be achieved. The company claims that the cage is very predator resistant, that nets are easy to clean, and that higher stocking densities are possible because of low net distortion. The design can be towed relatively easily, thus it is possible to bring the entire cage to a coastal processing facility. Feeding can be done by hand or through a centrally controlled system. The design is volume limited, extending to 5000 m^3 with present technology. With more engineering, it is hoped that a volume of 20,000 m^3 can be reached. The cost of the 3000 m^3 system is approximately US$25 /$m^3$ enclosed volume (excluding mooring).

Figure 2. Ocean Spar Seacage (a) and Sea Station (b) design (adapted from Loverich and Gace, 1997).

Trident Cage

The Trident cage (Figure 3) is the only fully submersible fish cage commercially available in North America (Willinsky and Huguenin, 1996). The 12 m diameter sphere (larger designs possible) is moored to the bottom by means of a wire on each hub, and vertical position is adjusted by way of a winch on each end (Rosenthal *et al*., 1995; Willinsky and Huguenin, 1996). By not being rigidly connected to the surface, it is more resistant to harsh hydrodynamic conditions and can be submerged to avoid severe weather. However, the culture of salmonids requires that they be given periodic contact with the surface waters in order to maintain the proper functioning of their swim bladders, and thus control buoyancy; the schedule of cage submersion must be carefully controlled

(Rosenthal *et al*., 1995). Autonomous operation will require further consideration and development of automatic feeding systems and monitors; Trident has developed an automatic feeder-monitor spar buoy for such purposes (Willinsky and Huguenin, 1996). The spherical design allows the cage to be rotated, thus controlling biofouling through killing of the organisms by exposing to the sun and wind; submersion can also control the biofouling organisms which require light for growth (Willinsky and Huguenin, 1996). The taut net of the Trident Cage has proved to date a successful deterrent for marine mammal and bird predators (Willinsky and Huguenin, 1996).
Figure 3. Trident cage design (adapted from Willinsky and Huguenin, 1996).

Farmocean Semi-Submersible Cage

Farmocean International, based in Goteborg, Sweden, has developed a line of offshore semi-submersible cages (Figure 4; Henriksson, 1996). To date, more than 40 systems are installed worldwide, mostly in northern Europe and the Mediterranean Sea including Scotland, Sicily, Malta, Cyprus, Madeira, and France (Henriksson, 1996; Lars Henriksson, pers. comm.). It consists of a steel structure mounted on a hexagonal pontoon, measuring 20 m across and 20 MT in weight. Four sizes are available- 2500, 3500, 4500, and 6000 m^3 with a production capacity of up to 150 MT. The 4500 m^3 facility can normally produce up to 110 MT of salmon (Lars Henriksson, pers. comm.). The various nets available are suspended from inside the structure and are interchangeable with the one structure. Experience has shown that the nets do not have to be changed during the growing cycle. Concrete blocks or anchors moor the system using a three-point configuration (Lars Henriksson, pers. comm.). Normal operating position is with the structure semi-submerged with the pontoon 3 m below the surface, and the upper work platform and feeding silo approximately 3 m above the surface (Henriksson, 1996). A circular sinker tube attached to the bottom of the net maintains its shape. Use of a predator net or predator panels (attached between pontoon and sinker tube) is also possible. Farmocean states that their systems have never experienced any attacks from predators (Lars Henriksson, pers. comm.). The structure can be equipped with an alarm to deter vandalism or theft when the structure is unoccupied.

The system has been verified to sustain 5.5 m waves, 35 m/s wind, and a 2 knot current (acting in the same direction), although practical experience has shown it to be able to occasionally withstand waves in excess of 10 m in combination with 7-8 m tides (Henriksson, 1996; Lars Henriksson, pers. comm.). The feed silo holds up to 3 MT of dry pelleted food, and refilling is facilitated with pneumatic transport system to transfer feed from a barge or service boat. Feeding is automatic and programmable. Morts can be collected by a diver from outside of the net by opening a bottom sock, thus reducing the stress on the fish. Recommended stocking density is 20 kg/m^3. A typical 4500 m^3 system with mooring and feed conveyors costs approximately CAN$400,000.

Figure 4. Farmocean semi-submersible cage design (adapted from Henriksson, 1996).

Submerged SADCO-Type Cages

The SADCO series of submerged cages (Figure 5) have operated in offshore environments since 1985 and are the only truly underwater fish farming system in the world proven for extreme weather conditions (Leonid Bugrov, pers. comm.). They were developed in Russia in a response to the need to more readily regulate the environment for the cultured fish by positioning the cages vertically in the water column to take advantage of more optimum temperature and oxygen regimes (among others) and avoid the harsh surface conditions of winter (Bugrov, 1996). The system was originally developed and has been successfully used for salmonid culture in the Black Sea and the Caspian Sea (Bugrov, 1996; Leonid Bugrov, pers. comm.). The salmonids successfully commercially cultured include Atlantic salmon, Coho salmon, and Rainbow trout. The company focuses research and development on providing a wide array of submersible cages, starting from relatively inexpensive simple cages designed for small scale "family use" to fully automated systems designed for industrial use (Leonid Bugrov, pers. comm.). There are currently 32 facilities operating, with 9 more planned for installation this year, most being used commercially with only pilot units of new versions being used as research cages.

The basic structure for all designs consists of a three-dimensional rigid hexagonal frame. For smaller units, the frame reduces to a pyramid on the top, where a pontoon, working walkway, and feeder are positioned (Bugrov, 1996). Larger units consist of two hexahedral pyramids which share a common base at the center of the structure; the feed bunker is again positioned at the top, but ballast tanks are part of the cage framework and there are two servicing walkways- one around the feeder and one around the central pyramidal base. The small size of some cages (e.g., 100 m^3), however, have proved to be uneconomical to operate. Larger systems have now been developed, up to a 4,000 m^3 capacity. A further design uses a combination of the rigid hexagonal structure and a suspension system for the cage bottom, reducing the amount of steel used in construction and improving transportability.

For all cages, an automatic underwater feeding system allows for continued supply of food under storm conditions. Ballast tanks control the vertical position of the cages (Bugrov, 1996). Automatic, computer controlled vertical positioning can be achieved and linked to certain desired culturing conditions, such as temperature (Bugrov, 1996). With automated feeding and monitoring, surfacing and servicing of the cages is only required approximately every ten days with some designs (Leonid Bugrov, pers. comm.). With prolonged submersion, maintenance of hydrostatic balance for fishes with an open swim bladder is achieved by use of an air chamber (inverted cup) in the cage (salmon gulp air to maintain swim bladder function). For species with a closed swim bladder, it is essential that any changes in depth are gradual to allow the fish to adapt. Many of the smaller cages can be joined together into a larger honeycomb superstructure of six cages, allowing for simultaneous fish grading and transfer work among several cages.

An analysis of financial viability of the system must be based on specific data on the site and the system to be used, and thus not generally available (Leonid Bugrov, pers. comm.). Rearing densities for salmon have reached 26 kg/m^3. In floating position, permissible wave heights are 2 m, while submerged this increases to 15 m. The structures can operate in currents up to 1.5 m/s. Depth of installation has been between 15 m and 80 m, depending on specific site limitations, with distances offshore up to 80 km.

Figure 5. SADCO 500 (a) and SADCO 1200/2000 (b) submerged cage designs (adapted from Bugrov, 1996).

SITING REQUIREMENTS

The number of suitable coastal sites for the traditional floating net-cage design is limited in the face of restrictive siting criteria required to ensure an acceptable level of impact on the marine environment and to reduce interaction with competing coastal resource users. Siting characteristics must also be appropriate and beneficial for salmon production. A movement to offshore production would open up many new opportunities to farming, and may indeed be necessary for the expansion of the marine aquaculture industry worldwide (Willinsky and Huguenin, 1996).

Many siting constraints are associated with the near shore environment, but not necessarily with offshore locations, depending on the location and distance from shore. Site constraints include proximity to communities, First Nations territories, salmon streams, shellfish beds, marine protected areas, marine mammal haul-outs and recreation zones. Other siting engineering constraints are associated with the traditional floating net-cage design and not offshore systems, including the necessity to avoid high current sites and areas exposed to large waves. It is the ability to move away from the coast which could offer alternative farm siting.

The requirements for the physical siting of an offshore aquaculture facility are relatively few- deep water and access to sufficient on-shore facilities and services (facilities must be reasonably close). Specific system designs may have particular siting restrictions. For example, bottom mounted submersible cages must be deep enough to be protected, yet still be able to be accessed by divers, limiting the number of suitable sites (Willinsky and Huguenin, 1996). The extent to which new concerns over safety and liability arise (e.g., collision with vessels) must be considered before siting decisions are made.

SYSTEM BENEFITS

Overall, turning to more exposed or offshore aquaculture may have the following benefits: (i) avoiding conflicts with adjacent land owners, (ii) decreasing conflicts with competing coastal resource users, (iii) reducing stress on cultured organisms through use of high volumes of predictable, stable, quality water, (iv) reducing interactions with predators, (v) reducing stress on coastal environments if nutrient loading is already at or near the carrying capacity of the system,(vi) reducing regulatory and permit requirements for industry, and (vii) permitting the culture of high quality, high value open ocean species (Karlsen, 1993; McVey, 1996; Willinsky and Huguenin, 1996). Item (vi) may or may not be seen as desirable, but as most government marine management is currently concerned with coastal or foreshore resources and environments, locating operations a significant distance offshore would likely reduce regulation and policy requirements. Comments regarding offshore aquaculture system benefits for various system types as adopted from Willinsky and Huguenin (1996) are shown on Table 1. Some advantages and disadvantages noted on Table 1 may not be relevant to particular manufacturers' designs. All offshore technologies reviewed here are still open net systems. However, offshore location of the industry, in more secure cage systems, addresses a number of environmental concerns, such as potential benthic smothering, beach fouling, nutrient loading of coastal waters, and farm-predator conflicts. The taut netting, rigid structure, or large circular design of many of these systems, in conjunction with the offshore siting, greatly reduces or eliminates the need for predation control. Concern over farm fish predation on certain larval and juvenile marine organisms is reduced where the life-stages are associated with near-shore waters. The nature of the effects where life history strategies of certain marine organisms, including plankton and larval or juvenile life-stages, could be deleteriously impacted by offshore operations needs to be investigated further. Use of medications in an open ocean environment may be reduced as the sites are expected to have reduced incidence of disease with increased flushing rates of quality water through the cages. Submerged systems also afford the potential of using the cages in conjunction with reefs as a complex for environmental management, although this latter aspect would require further research before implementing.

Perhaps the greatest economic benefit which can be realized with the use of open ocean aquaculture systems is the free use of vast quantities of quality water for production (Forster, 1996). The better water conditions should

result in better health, growth and survival of the cultures species (Croker, 1996; Forster, 1996). Open ocean farming may allow for reduction of 'non-farming ' costs (slaughtering and boxing, transport, warehousing and delivery, cutting and merchandising) by concentrating many operations in a smaller area closer to on-shore facilities and markets than many traditional floating net-cage facilities are today (Forster, 1996). Again, offshore systems require that culture methodologies be adjusted and re-thought to fit the working environment, but they may result in greater economic advantages being realized in certain areas.

SYSTEM DISADVANTAGES

Certain constraints or challenges face such an industry move: (i) the requirement for new engineering less vulnerable to storm waves and wind, and larger, more expensive scale of operations, (ii) difficult operating logistics and the need for the development of new methods of servicing, monitoring, and maintenance, (iii) incomplete knowledge and ability to culture candidate species, (iv) uncertain lease, regulatory, and permitting requirements, (iv) lack of necessary financing and government assistance, (v) lack of government policy, and (vi) uncertainties about liability and the danger of impact with large ocean-going vessels (McVey, 1996; Willinsky and Huguenin, 1996). It appears from this overview that much advance has been made in items (i), (ii), and (iii). The most pressing need, as far the development of an offshore industry is concerned, is for governments to clearly define regulatory and management regimes. Locating systems in federal waters would result in a shift from provincial to federal jurisdictional control for siting. The legal regime and potential liability issues were not researched for this paper.

There are some environmental concerns for the cultured fish. Stress and reduced feeding activity may result in lower fish growth for sites which use floating or semi-submerged structures and which are continually exposed to heavy waves and storm surges as fish are exposed to the water motion (Bugrov, 1996). Offshore location can also present special harvesting and servicing challenges, especially in the poor weather. These may be detrimental to the fish if specific technologies or methodologies are not employed which bear this in mind. Documentation of the nature of potential increases in risk of an escape event due to collision with ocean going vessels could not be found.

Perhaps the greatest economic disadvantage faced with offshore aquaculture is the initial capital costs of the systems (Forster, 1996). When costs for the development and employment of an offshore facility are very high, economic viability will be questionable (Loverich and Swanson, 1993). Given recent advancements, however, and the possibility of savings in other areas of production and the application of new methods, this concern appears to be diminishing. As outlined above, numerous commercial facilities are successfully operating worldwide. Socio-economic implications of locating systems a significant distance from shore need to be considered. It is reasonable to expect that there would be a natural concentration of activities in both production and on-shore processing to achieve economies of scale. This may shift economic benefits away from coastal communities towards larger population centres. Questions also arise regarding the implications for working conditions and workers safety in an offshore environment.

Table 1. Advantages and disadvantages of offshore marine aquaculture systems as adopted from Willinsky and Huguenin (1996).

System Type	Advantages	Disadvantages
Bottom-Mounted Submerged Cage	• avoids storm forces and stresses • biofouling control difficult • reduced biofouling	• difficult to monitor, service and maintain • security from vandalism and theft • complex mooring system
Bottom-Mounted Barrier System	• avoids storm forces and stresses (requires radically new methods) • reduced biofouling	• difficult to monitor, service and maintain • security from vandalism and theft
Surface Operated, Bottom Mounted Nested Cages	• proximity of units simplifies operations • established management methods	• severe structural problems during storms; history of structural failures • high maintenance

saline stability
experience with system use
components thus
avoiding surface debris and
shadowing
• thermal and
• little
• few surface navigational concerns
saline stability
experience with system use—
components thus
avoiding surface debris and
• thermal and
• no
conceptual designs yet to be funded
• few surface navigational concerns
• downstream

Surface Operated, Bottom Mounted	• failures unlikely to cascade to other units operations	• history of structural failures**Large Single Cage (surface or** • separation and size complicate**semi-submersible)** • fish susceptible to washing-out of top •
volume loss in currents **Surface Operated, Bottom Mounted**	• avoids storm forces • ability to avoid potential poor water	• problems typical of large surface cages**Submersible Cage**
associated with surface **Surface Operated and Moored**	• experience with systems • mobility allows avoidance of seasonal	• submergence adds complications quality
weather and seeking of optimal architectural	large size • high water exchange	• storm survival in open sea requires**Barge/Ship Systems**
ship design and operations relatively	• problems with mooring systems and • high cost	water quality • require development of methods for culture and operation • can utilize known naval principles structural integrity of moored vessels • low risk

CLOSED CIRCULATING MARINE SYSTEMS

SYSTEM DESIGN AND TECHNICAL FEASIBILITY

There are two main types of designs which have been conceived for closed circulating floating marine systems: a closed-wall cage and a floating raceway. The first type more or less resembles the traditional net-cage structure with the exception that an impermeable membrane is used in place of a net and a pump with an adjustable intake directs water into the cage with a passive outflow on an opposing end of the system. The closed-wall cages have the potential of being further modified by devising a system of solid waste collection from the bottom of the cage. The floating raceway would have essentially the same elements as the closed-wall cage, but with a linear configuration. It must be noted that these systems are 'closed' in that an impermeable membrane separates the fish from the surrounding marine environment; they are still flow-through systems. The raceway was initially developed as an alternative to the circular closed-wall cage as it was suspected that the characteristics of the water flow would enhance the quality of the fish, having to maintain a higher level of exercise (Karlsen, 1993). No record was found of raceway type systems currently being used. Two competing circular floating closed marine systems, both being developed in the Pacific Northwest, are described below. They are believed to be representative of the state of the technology.

Examples of Systems Developed

Future SEA Farms

A closed wall cage system has recently become commercially available in British Columbia from Future SEA Farms Inc. of Nanaimo, BC (Figure 6; Future SEA Farms, 1997). The system has been installed near the Pacific Biological Station (DFO), Departure Bay B.C., for testing and demonstration purposes using Atlantic salmon. Further systems are being piloted with West Coast Fishculture (Lois Lake) and Phillips Arm Seafarms for research and development. Cage walls are composed of a flaccid PVC-coated woven polyester, which is resistant to fouling. Water is pumped through the bag at about 120,000 l/min. Oxygenation can be done as needed. The flow pattern directs solid wastes and excess feed to the bottom where they could be removed via pipe discharge. The system does not yet have the ability to concentrate wastes for further processing. The waste management technology for this bag system is the least proven component (Bernie Bennett, pers. comm.). There are no immediate plans for associated waste treatment, but the company is looking to a system that collects and can direct waste by pipe away from the grow-out site. Similarly, it is expected that water can be pumped into the system by pipe to access better quality water at times of phytoplankton bloom. The producers claim that the surfaces will not be readily colonized by fouling organisms, and it is expected that those that do settle on the units can be easily removed by divers. The record of the test bag in Departure Bay should provide some information regarding this.

Start-up capital costs are at least double that of a traditional floating net-cage design (Bernie Bennett, pers. comm.). Bags alone cost about six to seven times what it can cost to purchase a comparable net (Ward Griffoen, pers. comm.). However, the company claims that the higher stocking densities and improved growth rates and levels of fish health afforded by the water circulation system will compensate. Stocking densities are projected at 30-60 kg/m^3, although current test sites run closer to 8 kg/m^3 (Bernie Bennett, pers. comm.) It is not expected that the system would be profitable below densities of 30 kg/m^3. There have been some technical difficulties with the pilot system installed at Lois Lake associated with fish handling (getting smolts out of the bags in a timely manner without undue stress) and water pumping (need for more pumps than originally conceived). Due to these problems, the unit is currently sitting idle (Ward Griffoen, pers. comm.).

Unlike open marine systems, water in a closed system must be circulated. Pumps which drive the water flow are powered by a generator. There must also be fail-safe systems on hand to ensure that the required energy is always available for pumping. Salmon would not survive in the cages without water circulation and, for higher rearing densities, aeration. Energy costs do not appear to be prohibitive, but the technology adds a layer of complexity to operations and possible additional concerns (e.g., added use of fuel and oil on site and operation of machinery 24

hrs a day; Ward Griffoen, pers. comm.). Overall, the technology looks promising, but biological or economic viability has not yet been ascertained (Bernie Bennett, pers. comm.). No commercially operating facilities are in place. Current units are being manufactured outside of B.C., but the manufacturing technology would be available locally. The pumps for circulating the water have been developed specifically for this technology. Wave testing on models are currently underway at Malaspina College in Nanaimo, B.C.

Figure 6. Future SEA Farms design (adapted from Future SEA Farms, 1997).

MariCulture Systems

Sargo FinFarms are closed circulating marine systems produced by MariCulture Systems Inc. of Lynnwood, Washington (Figure 7; MariCulture Systems, 1997). A demonstration facility is currently operating off the US National Marine Fisheries Service site in Manchester, Puget Sound (Bill Evans, pers. comm.). The rigid walls of the circular tanks are composed of woven and stranded rigid fibreglass, reinforced with a plastic resin composite, and measure approximately 18 m in diameter and 8.5 m deep (6.75 m lies below the water line), with a disked bottom and a rearing volume of 2,000 m^3 and product weight of 100 to 140 MT (MariCulture Systems, 1997). Tanks can be coated with an antifoulant and equipped with bird netting or covers to prevent surface predation. The rigid structure protects the stock from predation, and greatly reduces the chance of escapes. Multiple water inlets can be accommodated at variable depth, with a maximum flow rate of 37,850 l/min per tank. Each self-contained unit can be equipped with injection diffusers and tanks for manually controlled or automatic oxygenation. The circulating flow of water deposits solid wastes in a bottom sump. A sump pump removes solids to a 500 gal collection tank located on an adjacent service building (MariCulture Systems, 1997; Bob Work and Bill Evans, pers. comm.). The sewage is then treated to 'deactivate' all solids using a unit similar to that used on cruise ships, and the resulting 'paste' retained for periodic disposal off-site (estimates are that under full operation this will be required every three to four months). The quality of the benthic environment below the tanks at the demonstration site have not changed since installation and operation (Bill Evans, pers. comm.). As in open net-cages, mort removal is conducted by divers.

The demonstration unit currently operates with a rearing density of approximately 15 kg/m^3, but it is believed that this could currently be raised to 20-22 kg/m^3 (Bill Evans, pers. comm.). It is anticipated that a density of approximately 35 kg/m^3 would be necessary to pay for the incremental costs of installing and using the system. Electricity costs associated with the necessary pumping of water amount to $0.03 to $0.06 /lb of fish raised. Oxygenation adds further costs. The company has reported more rapid growth of Atlantic salmon and lower feed conversion ratios than cohorts grown in a traditional floating net-cage system. The lower feed conversion ratios, higher stocking densities, reduced losses from predation and disease and lower labour costs would assist in paying for the incremental costs of using the system.

Figure 7. MariCulture Systems Sargo FinFarms design (adapted from MariCulture Systems, 1997).

SITING REQUIREMENTS

Overall, many of the siting requirements for closed circulating marine systems are similar to those for a traditional floating marine net-cage. Closed circulating marine systems are believed to be more affected by currents and waves (Karlsen, 1993), thus potentially restricting the units to siting in relatively sheltered locations. However, no documented evidence of this problem was found, and in fact one local developer of the systems claims that the soft-sided closed walls are not vulnerable to many of the hydrodynamic forces to which net cages can be susceptible (tests have indicated that the bag is unaffected in currents up to 2.7 knots with minor distortions at 3.5 knots; Future SEA Farms, 1997). Rigid walls may be able to resist such forces.

Appropriate waste discharge control and treatment technologies are not yet fully developed, but it may be possible for operations to move into sheltered sites with flushing and current conditions not currently suitable for fish farming. However, to be biologically feasible, access to quality deep water is necessary for intake into the bag or tank (Karlsen, 1993). This could require elaborate piping and pumping systems. Some of the siting concerns raised during the Salmon Aquaculture Review, such as conflicts with competing coastal resource users, would not be answered with deployment of this technology alone. For example, many coastal resource users in the tourism industry may find these units affect the quality of the outdoor experience, given the need for additional above water structures to house equipment and the sounds associated with operation (e.g., generators and pumps).

SYSTEM BENEFITS

The primary impetus for the development of closed circulating marine systems to date has been the benefits that can be achieved by controlling the environment for the cultured fish. Problems encountered with harmful phytoplankton blooms, less than optimal temperatures, and exposure to pathogens can all be decreased or eliminated by controlling the source of the water intake and the outflow discharge (Karlsen, 1993; Bob Work and Bernie Bennett, pers. comm.).

Interactions with predators can be expected to be lessened with use of this technology, as aquatic mammals can not see or get at the fish in the cage (Bernie Bennett, per. comm.). This has indeed been the experience of the local developers on their design test sites. Consequently, the risk of escape events from damage to the containment systems should also be greatly reduced.

Use of the systems has the potential to allow for lower impacts on the surrounding marine environment. For example, systems may be enhanced and modified to collect solid wastes from the bottom of the cage or tank. The collection of solid wastes will alleviate concerns over benthic smothering under the net cages, and has the potential to control the release of antibiotics and antiparasitics (i.e., ivermectin) into the marine environment. Effective and feasible systems for treating large amounts of solid waste generated by a farm is currently still under development. If solid wastes are simply directed by pipe from the site into deeper waters with sufficient current, it is possible that through this process any residual antibiotics in feed or feces would become diluted and thus lessen the potential impact. Technology to treat water effluent from these systems is not available.

The pumped circulating water in the closed marine systems forces the cultured fish to continuously exercise. It is thought that this in turn would increase metabolic efficiency, improve muscle tone, and result in a flesh which is firmer and more marketable. However, producers that have been experimenting with this technology have found the 'skinny' fish to be not as desirable a product as fish produced in traditional open net-cages.
Provided with a freshwater source, closed systems can accommodate a freshwater environment for the purposes of broodstock maturation and spawning. This provides the advantages of more rapid and uniform maturation among broodstock and less risk of problems due to exposure to seawater, without incurring the exceptional costs of a land-based, broodstock facility. Such systems, when in saltwater or estuarine environments, can also permit the gradual mixing of fresh and salt water to achieve desired increases in salinity along a predetermined schedule during the transition of smolts.

SYSTEM DISADVANTAGES

The disadvantages of using the systems include higher capital costs, higher energy use (associated with pumping/water circulation and possible waste processing), and the higher risks to the culturalist associated with system failure (Karlsen, 1993). Safe-guards must be in place in the event that the pumps which drive the recirculating water fail, or the enclosed environment will quickly become toxic to the fish.
The systems do not address many of the concerns which have arisen during the Salmon Aquaculture Review concerning the operation of traditional floating net-cages. Water is still pumped through the system, so issues of the potential shedding of fish pathogens into the environment is not addressed. However, the reported healthier performance of the fish will further reduce the likelihood of disease transfer from farmed to wild stock. Larvae or juvenile fish pumped into the system may be at risk of being killed or consumed by the fish. However, it is believed that lights used within these systems, if properly placed, would not attract outside fish to the system, but even if attracted these fish could not enter the system.
Waste treatment appears to be further along in the MariCulture system than the Future SEA Farms system, but likely will not answer all concerns regarding waste. As mentioned above, dissolved organics and metabolic wastes are discharged untreated into the receiving water column. There is the potential to collect and direct effluent, but this technology is not yet developed.

LAND-BASED SALTWATER SYSTEMS

SYSTEM DESIGN AND TECHNICAL FEASIBILITY

In the most basic form, land-based saltwater grow-out facilities consist of deep water ocean or saltwater aquifer intakes, pumps and pipelines, the saltwater ponds, effluent structures and site buildings. With increasing sophistication, other components may be added, including oxygenation, effluent clarification, treatment of sludge, removal of nitrogenous waste, disinfection with ozone/ultraviolet, temperature modification and recirculation. Generally, these components increase the capital cost and operating complexity of the facility, but improve control of the husbandry environment and reduce impact on the environment and are essential for growing salmon. The addition of recirculation can be expected to reduce pumping cost and facilitate the maintenance of an optimum environment (Babtie Shaw & Morton, 1988; Graham Willaby, pers. comm.).

Facilities may be used strictly for the grow-out of fish to market size. However, broodstock maturation and spawning, and freshwater incubation and rearing must also be accommodated. These life cycle stages could be provided for on the grow-out site where there is access to sufficient high quality freshwater and opportunity for discharge of the freshwater effluent.

Research on the design of land-based systems in general has been focused on farm layout, production systems, fish tank size and shape, water flow systems, intake and outflow design, and water treatment (Karlsen, 1993). Designs for land-based saltwater systems have included the use of circular tanks, raceways, and even closed pipe systems. With the latter, large pipes are partially buried and the salmon are cultured within the pipes with an oxygenated flow-through water supply and traps for waste removal placed at intervals along the length (Karlsen, 1993); the closed pipe system is currently highly experimental in design.

Recirculating Technology

The development of recirculating technologies for use on land-based systems is advantageous because of the ability of the culturalist to (i) more fully control the environment for the fish, (ii) reduce the amount of water that is required for replacement, and (iii) minimize negative environmental impacts associated with effluent discharge or large volumes of water flowing through the system (Rosenthal *et al*., 1995). In fact, it is the possible negative environmental effects and high costs associated with the pumping of vast quantities of water which must be avoided. Without a recirculation system, it is not likely that a land-based salmonid grow-out operation will be truly feasible in a B.C. context.

A recirculation system normally is comprised of a series of pumps (which may or may not involve oxygenation), mechanical filtration (for removal of solid wastes), and biofiltration (for removal of nitrogenous waste products, dissolved and suspended organic matter). Ozonation can be effective in assisting in breaking down of organics not easily degraded in the biofilter (Rosenthal and Black, 1993). Sterilization of the water may also be required (UV treatment for the control of bacterial growth), but this treatment may not help performance in the face of poor biofilter design and use (Rosenthal and Black, 1993). The removal of suspended solids can employ the use of settling tanks, tube settlers, crossflow sand filters, and mechanical systems (e.g., triangle filters, drum

filters); biofiltration may use upfow/downflow or trickling filters with enclosed support material for bacterial growth (Rosenthal and Black, 1993).

In assessing the economic and practical feasibility of recirculating technology, it is often difficult to separate out problems due to inexperience, an inappropriate design selection, or poor financial planning (Rosenthal and Black, 1993). Furthermore, the specific requirements and sensitivities of the cultured species need to be considered, and may not allow for the use of conventional recirculation technologies (Rosenthal and Black, 1993). One can expect to be faced with a process of 'learning by doing'. The development of recirculating technologies for culture of freshwater species or salmonid smolt production has been significant (e.g., Eikebrokk, 1990; Eikebrokk *et al*., 1995; Libey and Timmons, 1996; Timmins and Losordo, 1994), but their applications to a commercial saltwater salmonid grow-out facility cannot be assumed. Two sources of technologies were identified which could be applied specifically to saltwater salmonid culture.

Examples of Recirculation Technologies

Intensive Aquaculture Technology Ltd. (United Kingdom)

Intensive Aquaculture Technology Ltd. of the United Kingdom have developed recirculation technology to the point where 1 to 5 % of the water volume in a land-based facility would require replacement daily (Graham Willaby, pers. comm.). The company has not yet built a land-based aquaculture facility for salmon, but is confident that with high water flows and oxygenation, 100-120 kg/m^3 could be achieved for adults. The initial capital investments are high (about double that of a traditional cage structure) but the facility would be expected to have a longer life. Subsidization for the construction of such a facility would be required, and at today's market values for fish, profits would be marginal. Economic and technical feasibility, without any current operating facilities, must be questioned.

MEGA FISCH (Germany)

The German company MEGA FISCH Gmbh specializes in the production of saltwater and freshwater land-based circular tanks and raceways with recirculation technology (MEGA FISCH, 1997). They have completed development of a "super-intensive" recirculated facility for saltwater land-based salmonid grow-out based on a modular design from 200MT annual production potential and up; there are currently none operating commercially in the world, but they continue to operate a research facility (Werner Gaus, per. comm.). The recirculation system is composed of the following elements: mechanical filtration (60-100 m with capacity of 160-220 l/s), biological filtration (filtration of sediment, oxidation, nitrification—NH^4 to nitrite, and denitrification- nitrite to nitrogen), aeration and oxygenation (100-105 % saturation at intake, reducing to 60-65 % saturation at the outlet; MEGA FISCH, 1997). Disinfection with UV/ozonation is sometimes used at the intake (Werner Gaus, pers. comm.). Maximum required daily water replacement is 10 %. The company believes that with the first industrial system, they can reach stocking densities of 50-80 kg/m^3 (Werner Gaus, pers. comm.). Start-up capital requirements are high, depending on site, size of the system, equipment requirements, and training and feasibility studies. It is believed that a return on investment can be reached between three to five years (Werner Gaus, pers. comm.).

Current Land-based Systems

Land-based saltwater salmon grow-out facilities which currently exist and are operating in Scotland, Norway and Iceland were investigated for this review and are subsequently described. None use recirculation technology.

Landcatch Ltd. (Scotland)

Landcatch Ltd. (Argyle, Scotland) is an Atlantic salmon rearing facility which raises broodstock for egg supply to the industry (Martin Waterhouse and Bill Miller, pers. comm.). The 150 MT facility is composed of sixteen 200 m^3 tanks, one 1200 m^3 tank, and one 1400 m^3 tank and operates at a maximum rearing density of 30 kg/m^3. The seawater pumping capacity of the site is 1800 l/s. The facility is situated on a six to seven acre site, with a pump head 6 m from sea level. Sea water is pumped from one side of the island on which the facility is situated, and discharged on the other. There is no recirculation or water treatment. Seawater is screened at the intake for large seaweed. The rearing of production fish may be possible, but is not part of the business plan. This facility,

although expensive (to build a similar facility today would cost approximately 2.5 to 3.0 million pounds), offers the advantages of a controlled environment, ease of access, and good working conditions (Bill Miller, pers. comm.).

Otterferry Ltd. (Scotland)

Otterferry Ltd. has operated two sites, a larger grow-out site and a smaller broodstock site (Chris Hempleman, pers. comm.). The main grow-out site has 12 tanks measuring 12 m in diameter, each holding 175 m^3, and two tanks measuring 25 m in diameter, each holding 775 m^3. The pumping capacity is 10,000 Igal/hr. The broodstock site has two tanks measuring 32 m in diameter, each holding 2000 m^3, and two tanks measuring 45 m in diameter, each holding 4000 m^3. The grow-out site was closed for salmon production in 1993 as it was not economically viable given the market prices (the facility is currently being used to raise live feed for halibut culture). The maximum stocking density, achieved with oxygenation, is 50 kg/m^3. No recirculation is used and the water is discharged into the environment untreated. The contingency system in place in case of system failure consists of standby generators, oxygen packs, aeration blowers, and a skeleton staff on site at all times.

Aqua Scott Ltd. (Scotland)

West Coast Salmon (Aqua Scott Ltd.) is the only economically viable commercial land-based salmonid grow-out facility in the United Kingdom (Keith Agnew, pers. comm.). In order to run economically, the facility relies on fish of which give a higher return than market salmon. It achieves this by using a species mix-grow-out salmon, trout and turbot production, and salmon broodstock culture. The water is oxygenated to saturation and achieves a high stocking density of 30-40 kg/m^3 (can be pushed as high as 60 kg/m^3). There is no recirculation or discharge treatment in the facility. The initial investor went bankrupt, and the present owner purchased the assets at an extremely reduced price (William Crow, pers. comm.) thus significantly reducing the capital cost burden.

Current Land-based Systems in Iceland

Iceland built up to six land-based salmon grow-out facilities during the mid 1980's (Jonas Jonasson, pers. comm.). The farms are over 1000 MT in size each and two of the facilities take advantage of low-cost geo-thermal heat energy to maintain ideal temperatures for grow-out. Geo-thermal heat is used on all farms in the production of smolts. The majority of the farms have gone into bankruptcy since construction, but continue to operate under new management (banks let the facilities to private companies for operation). Due to the low required investment for the current operating companies (with bankruptcy, financiers absorbed the original heavy capital costs) and the benefits afforded with the use of geo-thermal energy, the land-based facilities are competitive with

traditional net-cage culture. The rearing density achieved with these facilities is approximately 50 kg/m^3. There are currently no plans to build additional land-based facilities in Iceland.

Current Land-based Systems in Norway

There are currently five privately operated land-based salmon farms in Norway (Omno Osnrnd, pers. comm.). Experience has shown that they are extremely expensive to operate, and facilities have generally gone bankrupt two or three times each since initial construction (typically, a farm is sold off at 1/80 th of the original capital cost). Again, the low investment costs of purchasing a farm that has gone bankrupt seems to be one prerequisite to an economically viable operation. Pumping costs can also be a significant financial barrier. Control of pollution from the farms has been effective, but stock continually have disease outbreak problems. There are currently no plans to build additional land-based salmon farms in Norway, primarily because financial institutions will not finance construction.

SITING REQUIREMENTS

Land-based saltwater farms require access to a quality water supply drawn from depth. The volumes and rates at which water is required depends on the design of the facility. Use of recirculation technology would greatly decrease water requirements, typically by approximately 90 to 95 % (the assessment by Simons Environmental, appended to this report, supports that 90% recirculation is maximal). The possibility of seaweed, sand or turbidity in the intake water must be avoided (Martin Waterhouse and Keith Agnew, pers. comm.). Shallow coastal areas pose difficulties associated with turbidity and an unstable water column limiting the reliability of water quality (William Crow, pers. comm.). Sites must offer stable and constant temperature regimes. Areas affected by plankton blooms that may reduce oxygen saturation are not suitable (Laird and Needham, 1988). Mixing of effluent into the intake must also be avoided (Babtie Shaw & Morton, 1988, p.53).

These requirements necessitate use of a relatively large flat foreshore area and steeply declining near shore to keep the pumping distance (which affect energy requirements) and the length of required piping (which affect capital cost requirements) to a minimum. Access to required infrastructure, such as roads and an electricity grid (or some other power source), are also required. Low head and tidal range are necessary (Babtie Shaw & Morton, 1988; Bill Miller, pers. comm.). Suitable land is generally prohibitively expensive or not available in many areas of British Columbia, and may be one of the greatest barriers to the establishment of land-based salmon farms in this province (Don Furnell, pers. comm.; see appended report by Simons Environmental). The more detailed assessment of a land-based facility produced for the EAO (Simons Environmental, appended) assumed that approximately 12.5 ha of suitable land would be readily available and inexpensive to attain. The bulk of this land was required for the stabilization pond (approximately 11 ha); thus the required land area could be reduced sugnificantly given investments in more capital intensive treatment technologies. This would, however, significantly increase costs.

SYSTEM BENEFITS

The main environmental advantages associated with moving to a land-based facility are the abilities to effectively control the environment for the fish (temperature, oxygen levels, water quality), decrease exposure to pathogens and harmful plankton blooms, decrease interactions with predators and other wildlife, and potentially overcom restrictive marine siting requirements. In at least one operating facility, experience has indeed shown minimal interactions with other animals (Martin Waterhouse, pers. comm.).

Certain other obvious advantages are associated with land-based facilities. Stakeholder conflicts in the near-shore environment may be minimized. Exposure to the adverse effects of current, waves and storms are avoided. The risk of stock escaping into the wild is considerably reduced, and likewise, the risks of genetic dilution of wild stocks, the establishment of wild populations of exotic fish and predation of escaped farm stock on wild fish are virtually eliminated. Predator-farm interactions can be eliminated, and so the use of acoustic deterrent devices, trapping or killing is avoided. With effluent treatment, environmental pollution could be negligible—solid waste, chemical waste and even dissolved waste can be removed. Certain routes of potential disease transfer between farmed stock and the wild are also eliminated provided that inflow and outflow water is properly sterilized. Photoperiod control is facilitated without the associated question of impacts on predation rates on other larval or juvenile marine species. There is no need for fallowing or other site restoration during operation.

Other, perhaps less obvious advantages, are associated with the opportunity to control the culture environment. Intake water can be oxygenated, allowing for increased rearing density. Food conversion ratios are improved as feeding can be very closely monitored. Also, the opportunity with some designs to achieve optimum temperature regimes improves food conversion ratios and growth rates (Graham Willaby, pers. comm.). The land-based facility can offer flexibility in the species that are raised, so that profit margins might be achieved with higher value species (Keith Agnew, pers. comm.). The farms offer better conditions for workers than the more remote cage sites (Martin Waterhouse, pers. comm.).

In order to become economically competitive, land-based facilities must realize higher stocking densities, higher growth rates, and reduced fish losses (Karlsen, 1993). Existing facilities must operate at stocking densities of at least 30-40 kg/m^3 (compared with a recommended density of 15-30 kg/m^3 for traditional marine net-cage culture) and raise species or broodstock which provide a higher return to be economically viable (William Crow, pers. comm.). Capital and operating costs, however, still appear to remain to be a barrier. There may also be the potential to differentially market the product and command a higher price if fish quality is improved (i.e., through forced swimming exercise and maintenance of more optimal environmental conditions for culture; Karlsen, 1993). The benefits of this, however, have not been demonstrated. Experience in Scotland has failed to show sufficient price advantage for high quality salmon to warrant the increased cost of production (Chris Hempleman, pers. comm.).

Land-based systems clearly offer advantages for broodstock development and maturation. The rearing environment can be highly controlled and secured. Fish can be easily inspected for selection of desirable traits and for maturity. Broodstock in a pond can be anaesthetized prior to removal. The availability of freshwater facilitates maturation and increases the viability of eggs and sperm (Babtie Shaw & Morton, 1988, p.44).

SYSTEM DISADVANTAGES

Operators and owners of land-based grow-out facilities face continuing problems of being able to effectively deal with the treatment of solid waste and waste water (Karlsen, 1993), although technological advances may start to solve some of these problems in the near-future (e.g., Kristiansen and Cripps, 1996). Water recirculation systems may not be operationally feasible at this time due to the difficulty of treating such large quantities of water effectively (William Crow, pers. comm.). Some system designers claim they can build commercially feasible facilities (Werner Gaus and Graham Willaby, pers. comm.), but they have not done so to date. The cost estimate of a model land-based system (Simons Environmental, appended) suggests that there remains a significant cost margin between commercial viability and actual costs.

Certain environmental risks associated with open cage salmon farming are not substantially reduced with land-based technology. Fish may still be exposed to harmful algae taken in through intakes. Plankton, larvae or juveniles of other marine species pumped into the facility may be eaten or killed. Farmed salmon can be exposed to disease from the wild through water and entrained organisms, and unless effluent is disinfected, may still expose wild stocks to disease through similar vectors. It is also more difficult to isolate year classes in a land-based facility, further complicating disease control (Laird and Needham, 1988).

These problems may be exacerbated by the vast quantities of saltwater required for a facility, especially without a recirculation system. The question is raised of possible environmental effects due to the removal of this amount of water from its point ocean source. This may be further complicated when water temperatures are seasonally high, as greater volumes of water may have to be pumped in order to meet the fishes' oxygen demand (Laird and Needham, 1988).

While a land-based facility practicing recirculation and water treatment will have negligible marine benthic impact associated with solid wastes, a permanent terrestrial impact of at least comparable size is anticipated to occur on the facility site. If a new road or other supporting infrastructure construction is required to service the facility, then the area of impact is increased by that amount.

Land-based facilities can fail economically because of the energy costs associated with pumping large quantities of water (William Crow, pers. comm.). The requirement to oxygenate, determined by the quality and consistency of the available water supply, can also have a major effect on the profitability of a land-based facility (Karlsen, 1993). High initial capital cost is also a contributing factor to economic failure (Rosenthal *et al*., 1995), as is evident from the above examples. Although land-based facilities depreciate more slowly than cage facilities, mitigating the high initial capital investment to some extent (Graham Willaby, pers. comm.), experience in other jurisdictions holds that the annual cost of capital remains at least three times greater, thus reducing any net annual surplus available to the producer given sufficiently high market prices.

The economies of scale make very large land-based facilities (500+ MT) somewhat less unattractive than smaller facilities (Babtie-Shaw & Morton, 1988, p.20). This, in conjunction with the required supporting infrastructure, suggests that an 'industrial park' type model may be most appropriate in terms of economic profitability, although access to an adequate and appropriate water supply then becomes the limiting technical factor.

There are further difficulties associated with production. Plant layout, location and design become fixed factors after construction that are difficult to adjust with changing culturing needs and technological advances (Bill Miller, pers. comm.). Increasing or decreasing the size of the facility, to accommodate market demand or changes in husbandry, is more difficult and expensive. Handling fish for harvest from a land-based system can be more difficult and traumatic for the stock. In cages, part of the population can be separated for harvest, leaving the rest of the stock in the cage unmolested. In a tank or pond system, however, the water level must usually be reduced and all the fish crowded before selected fish can be netted out. New technologies are required if handling of stock is to be improved.

To achieve economic viability, land-based systems often must be operated close to fish tolerance levels, so risks of stress and catastrophe are accordingly substantial. The dependency on the technology requires that back-up systems be implemented to guard against mechanical and electrical failure. Systems must be duplicated or triplicated to ensure stock is not lost (Babtie Shaw & Morton, 1988, p.51). Such systems are not generally economically available (William Crow, pers. comm.).

COST ESTIMATE FOR A LAND-BASED SALMON REARING FACILITY IN BRITISH COLUMBIA

The only land-based saltwater salmon grow-out facility to have existed in British Columbia, the Hagensburg facility, failed in the late 1980's due to the burden of the initial capital expenses. The operators of the 600 MT, flow-through (i.e., no recirculation technology) production facility were unable to pay financing charges and the facility was subsequently closed (Don Furnell, pers. comm.). Under new owners, the facility began operations

again this year. An attempt to culture Chinook salmon failed and the facility is currently sitting idle. Its future has yet to be determined.

Simons Environmental (Vancouver, B.C.) produced for the Salmon Aquaculture Review a process design and cost estimate for a hypothetical land-based Atlantic salmon rearing facility on the British Columbian coast. The full report is appended. The design assumed a 1000 MT/yr production capacity, with recirculation and water treatment technology, and stocking densities of 30 kg/m^3 and 50 kg/m^3. Specifically, the process design allowed for primary treatment, aeration, disinfection (of influent and/or recirulation water, and effluent from stabilization pond), nitrogenous waste removal, and 90% water reuse. The full report should be referred to for more specific information on the design and the assumptions that defined the analysis.

The estimate for the current capital costs of the facility was CAN$21-27 million, with additional operating costs of CAN$11-13 million (depending on assumed stocking densities). This leads to a required break-even price of $11.19 /kg ($5.09 /lb) for the salmon produced with a stocking density of 50 kg/m^3, and $12.85 /kg ($5.84 /lb) for the salmon produced with a stocking density of 30 kg/m^3. Given the assumptions used in the analysis and the current market p
0.753 scn0.4863 -0.0437 TD(u)Tj0 0 0 scn-0.0437 0.0437 TD(u)Tj0.753 0.753 0.753 scn0.5464 -0.0437 TD(r)

COMPARATIVE ANALYSIS

Table 2 summarizes the main advantages and disadvantages of the three types of systems as categorized in this paper:

- exposed offshore open marine systems,• closed circulating marine systems, and• land-based saltwater systems.

The assessment of the technical and economic feasibility of a technology, and balancing this with the environmental advantages which it affords, is based on the extent of the information which was available on current systems and the logical ramifications of their use. Economic feasibility based on past and current experience is defined in the narrowest sense, without full cost accounting. No independent audit of the information provided was usually possible. Primary environmental costs and benefits are qualitatively described.

EXPOSED OFFSHORE OPEN MARINE SYSTEMS

Various offshore cage designs are technically feasible and operating commercially throughout the world. There are no obvious prohibitive barriers for the industry to use similar systems on this coast. Costs to the industry to change to such systems, in light of allocating a fair and reasonable access to the coastal resource and the overall risks associated with current inshore operations, must be considered. In many cases, new culturing methods and procedures would have to be employed. The additional sites available offshore, however, provide a means for expansion given the limited availability of more sheltered locations. The higher quality rearing environment found in many exposed locations, among other factors, may result in higher productivity offsetting the required higher capital investments. As stated previously, there would be a required change to production techniques and use of technology, but it would not necessarily be a threat to the profitability of the industry.

Governments need to clarify the management regime for offshore aquaculture. Siting decisions and industry management, for many aspects, would likely come under the mandate of the federal agencies (i.e., moving farms outside of the ‘jaws of the land’ and thus out of provincial jurisdiction). However, in some cases the management regime would not be in question as certain exposed locations would still be relatively close to shore and in areas of clear provincial jurisdiction. By moving away from more sheltered locations, the industry could benefit from fewer conflicts with other competing coastal resource users and interest groups. There is, however, the potential to lose associated benefits to coastal communities for processing work if better product distribution services afforded by larger centres become readily accessible. Moving to more exposed locations may allow for a greater regional concentration of the industry. The patterns that have evolved for the wild fish industry could repeat for salmon farming, if large centrally-located offshore facilities were developed with concentrated on-shore agglomerations. Some questions of possible environmental impacts associated with working offshore would also need to be studied further, although there are some clear advantages to moving away from near-shore sheltered locations. Benthic smothering, potential enhanced nutrient loadings, and predator interactions would all be lessened. The better rearing environment which can be offered by open ocean locations may reduce the need for medicated feed. There may be a greater chance of a large-scale escape event due to structural failure or collision with a vessel, but with the proper engineering and safety precautions, the risk can be manageable.

CLOSED CIRCULATING MARINE SYSTEMS

Closed, circulating marine systems are becoming technically feasible for salmon grow-out. However, some components require further development and refinement to fully realize the benefits of using the system. As described above, commercial feasibility on this coast has not yet been demonstrated.

Environmental benefits over use of the traditional floating marine net-cage are the encouraging aspects of the technology. The farmer can more readily control the growing conditions for the fish stock, potentially increasing productivity. Solid wastes can be collected and treated, although the technology requires further development. Predation and escapes are virtually eliminated. These benefits are not achieved without other use offsets. For

example, conflicts with other coastal resource users which compete for space would continue, and may even increase if aquaculture facilities are allowed to move into more sheltered locations. Due to the flow-through design of the systems, some environmental concerns are not addressed. A high volume of water is required which may have an effect on plankton, or larvae and juveniles of other species. Water effluent is still discharged untreated into the marine environment.

LAND-BASED SALTWATER SYSTEMS

Many environmental concerns can be answered with use of a land-based system with recirculation technology. Emerging technology may be able to effectively treat large volumes of solid waste and waste water, while subsequently reducing the flow-through requirements. Interactions with predators and the risk of escapes can be virtually eliminated. With disinfection of effluent water, the potential for the transfer of a disease agent between farmed and wild stock is greatly reduced. With ozonation of the effluent, it is expected that much of the antibiotic residues from the farm would be effectively broken-down. The highly controlled rearing environment can provide near ideal conditions for the farmed fish.

The siting requirements for a land-based facility are very restrictive, and are perhaps the most discouraging aspect of this technology. The need to locate near the shore where land values tend to be high, will only further increase costs. High capital and operating costs can be potentially overcome given the appropriate institutional or financing conditions, but there are severe limitations due to the physical characteristics of the land required (i.e., large flat location near sea-level, with close, deep ocean water source). Such land, near the necessary services and supporting infrastructure, may be of limited availability or prohibitively expensive in the province. The potential for conflicts with adjacent property owners, given the industrial and large-scale nature of such an operation, can be expected to be significant.

Babtie Shaw & Morton (1988) compared sea cage and land-based systems for the grow-out of market Atlantic salmon. They offered the following advice: “In the past there has been much ill informed talk and many unwise proposals have been put forward for the ongrowing of salmonids in pumped ashore land based tanks. Unrealistic stocking densities, low quantities of water, and easy handling of the fish have been assumed. While we do not wish to discourage innovation, practical experience suggests that improvements in ongrowing techniques tend to be more evolutionary and in view of the large capital investment necessary and the element of risk, it is unwise to assume conditions which have not been achieved elsewhere.”

Almost ten years have passed since their report, yet the current state of technology and experience worldwide still supports this view. The development of technologies related to salmon aquaculture is incremental, building on previous components. A biologically and economically successful land-based facility requires that a particular suite of technologies be brought together and applied in an appropriate context. This is not yet achievable. Land-based salmonid grow-out facilities are by no means a demonstrated current viable alternative.

Table 2. Comparative analysis of emerging technologies for saltwater salmon grow-out, emphasizing primary advantages and disadvantages offered by employing each respective technology type.

System Type	Advantages	Disadvantages
Exposed Offshore Open	• proven commercial viability	• changes required in farming
Marine Systems	methodologies	• associated with near-shore coast
• investment in	(e.g., benthic smothering, potential	new capital
nutrient loading of inshore waters,	predator interactions)	• corporate focus
• less conflict with competing	• potential for navigational conflict	resource users
• uncertain government policy and	• potential for many new sites to	regulatory environment
become available for	• possible redirection of economic	• higher quality rearing environment
benefits	and services	leading to a potentially healthier,
higher quality product	• highly controlled, more optimal	• economic and technical viability
rearing environment for	unproved	• with solid waste collection and
• continuing competition	treatment, some coastal environmental	with other coastal resource users
issues addressed	• decreased interactions with	(high volume intake with untreatable
• predators	effluent) does not eliminate many	environmental concerns
• investments in	**Closed Circulating Marine Systems**	capital required
cultured fish	for space	flow-through nature of design
and level of escapes	more expensive	the industry
associated with processing		

Land-Based Saltwater Systems environment for culture fish and energy costs the marine environment eliminates escapes and treatment provincial availability unknown expected	• highly controlled, more optimal commercial viability doubtful at this time avoidance of potential deleterious water difficult, although technology • easier, safer working environment water intake and effluent still evident	• poor record of economic success- • with treatment technology, • treatment of solid wastes and waste associated with waste discharges • environmental issues associated with interactions with predators • highly restrictive siting requirements- • conflict with upland property users	rearing • extremely high capital impacts on is emerging • limits or without recirculation/

CONCLUSIONS

Any salmon aquaculture technology or employed methodology must be capable of producing product at a competitive price. Although it is possible for the producer to create a niche based on employing desired technologies or culturing new species to command a higher price for a short time, experience has shown that they inevitably must compete with the world market (Forster, 1996). Salmon, no matter how it is produced, must compete on store shelves with all salmon whether it is caught from the wild or farmed. It may be possible to create an 'organic' or 'environmentally friendly' market niche commanding a higher product price (as has been successful in other agricultural sectors), but the links between the alternative technologies available and whatever 'organic' or 'environmental' standards would be met are currently too tenuous or too ill-defined to be exploited. Such a market strategy may, however, become possible and beneficial in the near future.

When examining the operation of alternative technologies in other countries and regions of the world, one must also consider the ability to adapt the culture method to local conditions. The particular environmental, social and economic conditions of a jurisdiction must be considered when assessing the applicability of a technology. It is unwise to accept the feasible application in B.C. of a technology or culture method simply because it is used elsewhere. The transfer of technology is a complex process and may involve bringing together a required set of technical, biophysical, economic, and institutional parameters which will make the method viable (Rosenthal *et al*., 1995). Social conditions and values are also paramount to consider.

It is also unwise to consider advances in technology for salmon aquaculture in isolation from technical changes or demands in other areas of culture or marine use. Salmon farmers do not operate in isolation from other users of the marine environment or other industries. The employed technology should be compatible with other activities, yet afforded opportunities and a fair access to the resource for the farmer. In some instances, advances in knowledge and changes to methodologies can open up new opportunities for the fish farmer that are outside of what would traditionally be considered their normal practice. For example, recent work explores the possible co-culture of salmon, seaweed, and blue mussel using closed circulating marine systems (Bodvin *et al*., 1996) and salmon in land-based tanks with seaweed as a biofilter (Buschmann *et al*., 1996). The proposals are centered around the use of salmon farm waste water by seaweeds and filtering invertebrates. However, such integrated culture must be shown to be technical and biologically feasible, and provide an incentive for the salmon farmer (e.g., additional income derived from the marketing of the invertebrates or seaweed; Buschmann, 1996). This work is currently in an early stage of development.

The achievement of sustainable development in the aquaculture industry may mean that we re-evaluate the philosophy of "minimizing initial investments in order to shorten or maximize payoff schemes" (Rosenthal, 1995). If it is decided that the development of alternative technology and the use of alternative production strategies is necessary for the economic, social, and environmental well-being of the province, institutional arrangements will have to allow for the heavy initial costs of implementation. For example, requiring that the industry move to land-based production would not be economically feasible, as well as have some remaining technical questions and severe siting constraints, based on the review and analyses presented. However, if an appropriate location was found and operations conditions suitable, a land-based facility could be successful in this province if the initial heavy capital investment was substantially reduced or subsidized.

It is also important not to assess the feasibility of alternative technologies for aquaculture solely on the application of current methods (e.g., fish transfer, feeding net cleaning, mort removal, harvesting). It is not reasonable to reject an emerging technology simply because current culturing methods are not appropriate. New techniques can be developed that will fit the new technologies (Croker, 1996). Further, a full accounting of the costs and benefits of the use of an alternative technology must be given serious consideration when encouraging development and adoption. A high initial capital investment and low margin of return to the farmer may be more than offset by realized market or non-market benefits in other sectors. Institutions must be arranged to allow the fish farmer and society as a whole to take advantage of this.

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Figure 1. Typical floating marine net-cage design in use throughout coastal British Columbia.

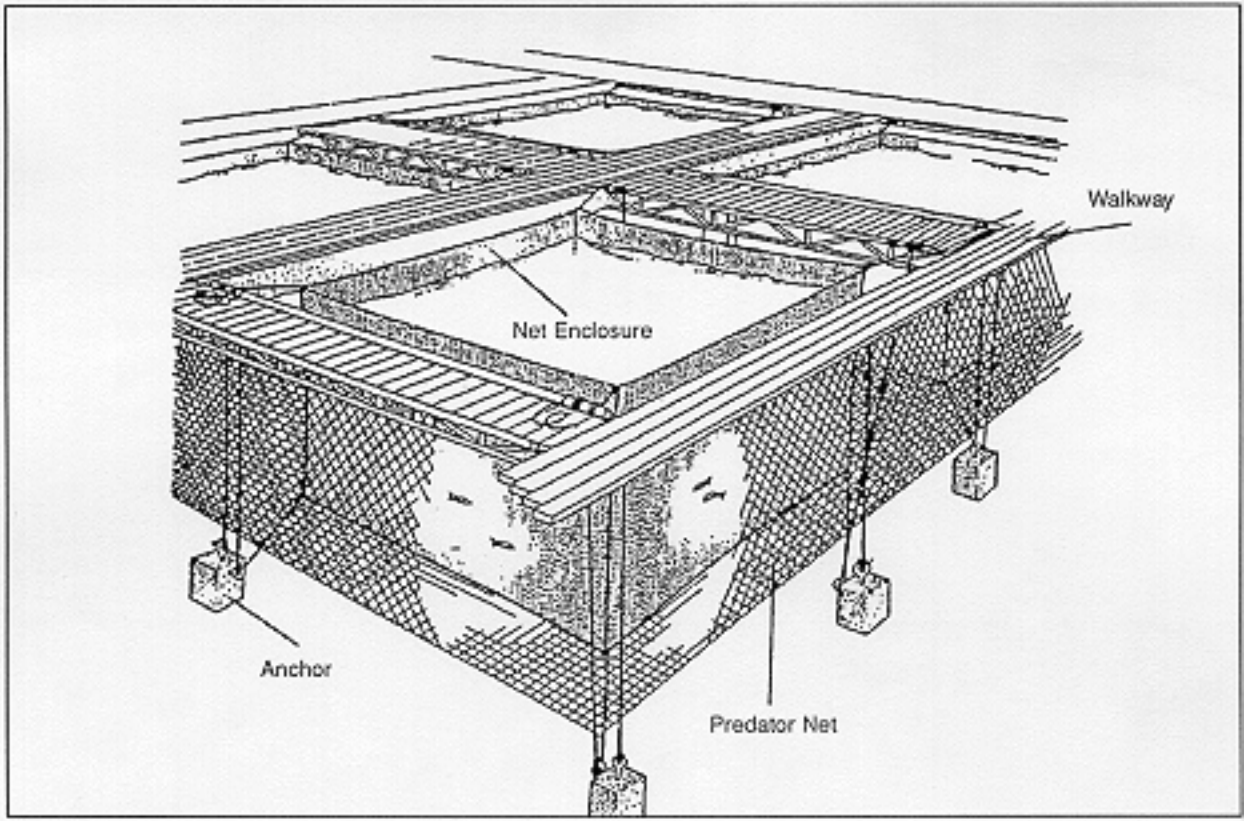


Figure 2. Ocean Spar Seacage (a) and Sea Station (b) design (adapted from Loverich and Gace, 1997).

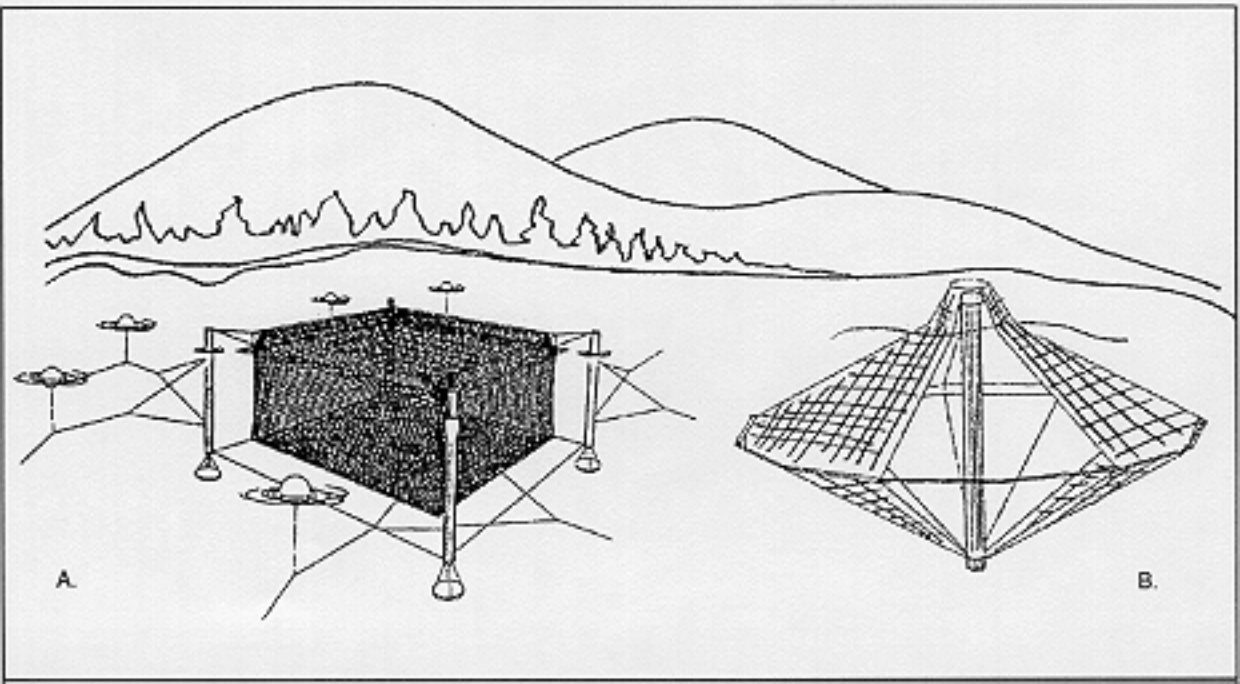


Figure 3. Trident cage design (adapted from Willinsky and Huguenin, 1996).

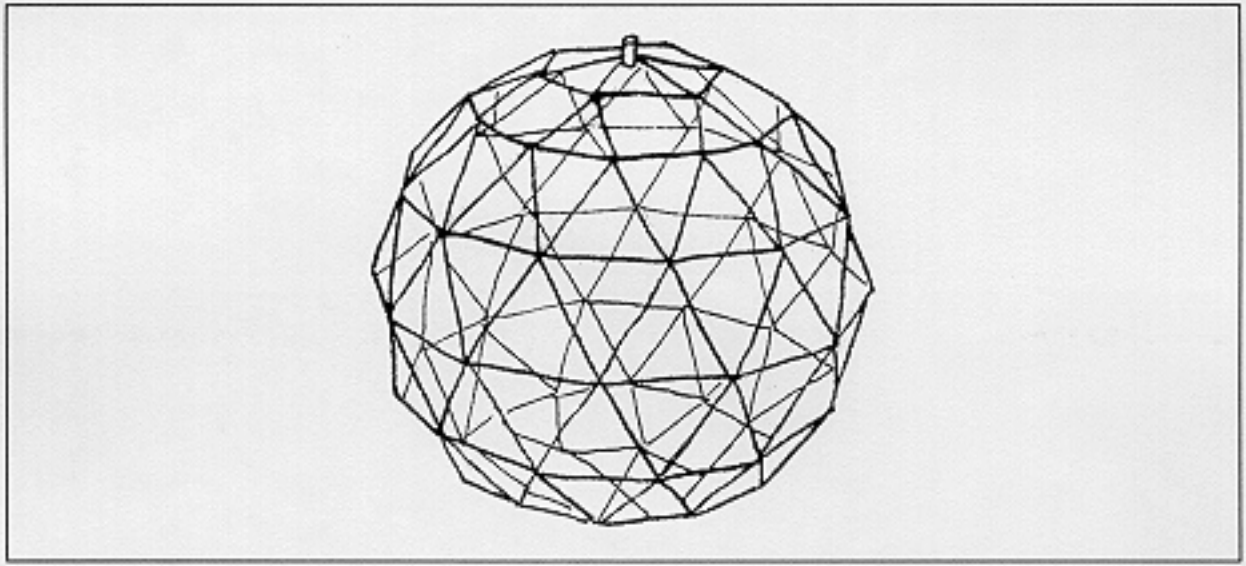


Figure 4. Farmocean semi-submersible cage design (adapted from Henriksson, 1996).

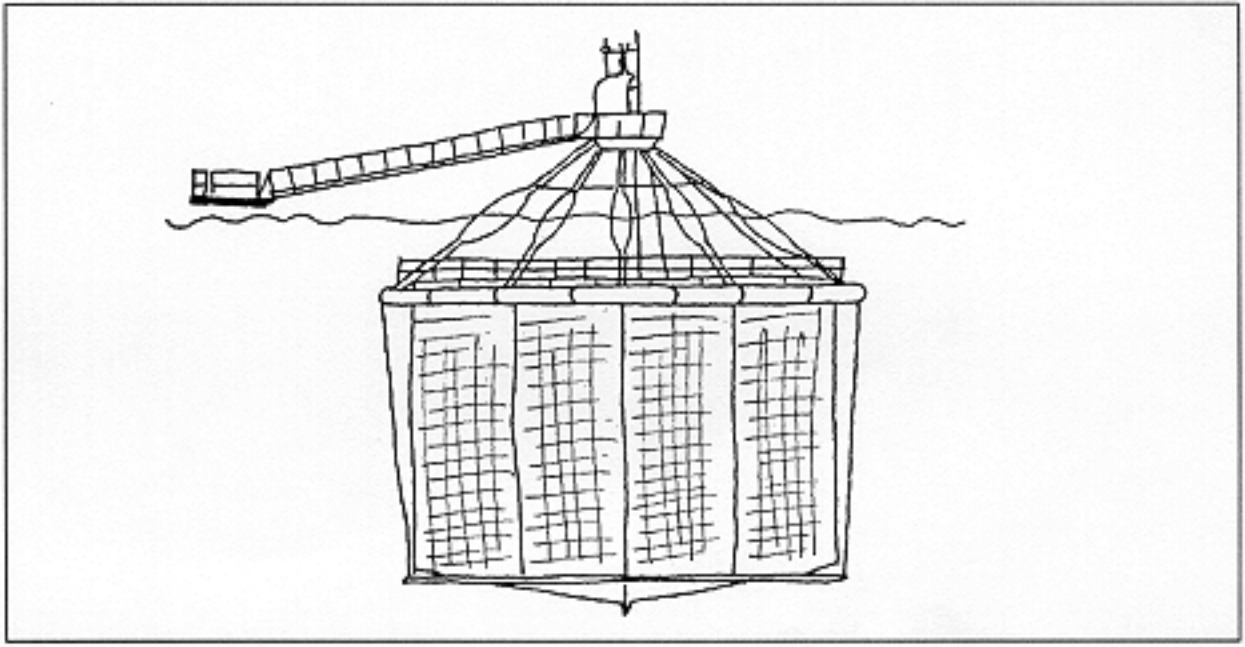


Figure 5. SADCO 500 (a) and SADCO 1200/2000 (b) submerged cage designs (adapted from Bugrov, 1996).

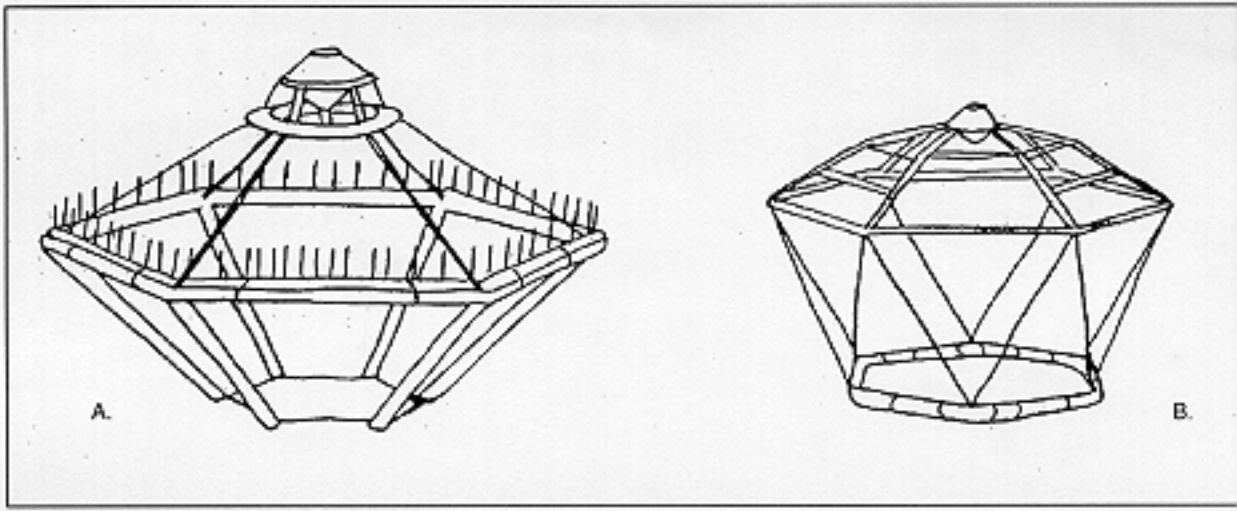


Figure 6. Future SEA Farms design (adapted from Future SEA Farms, 1997).

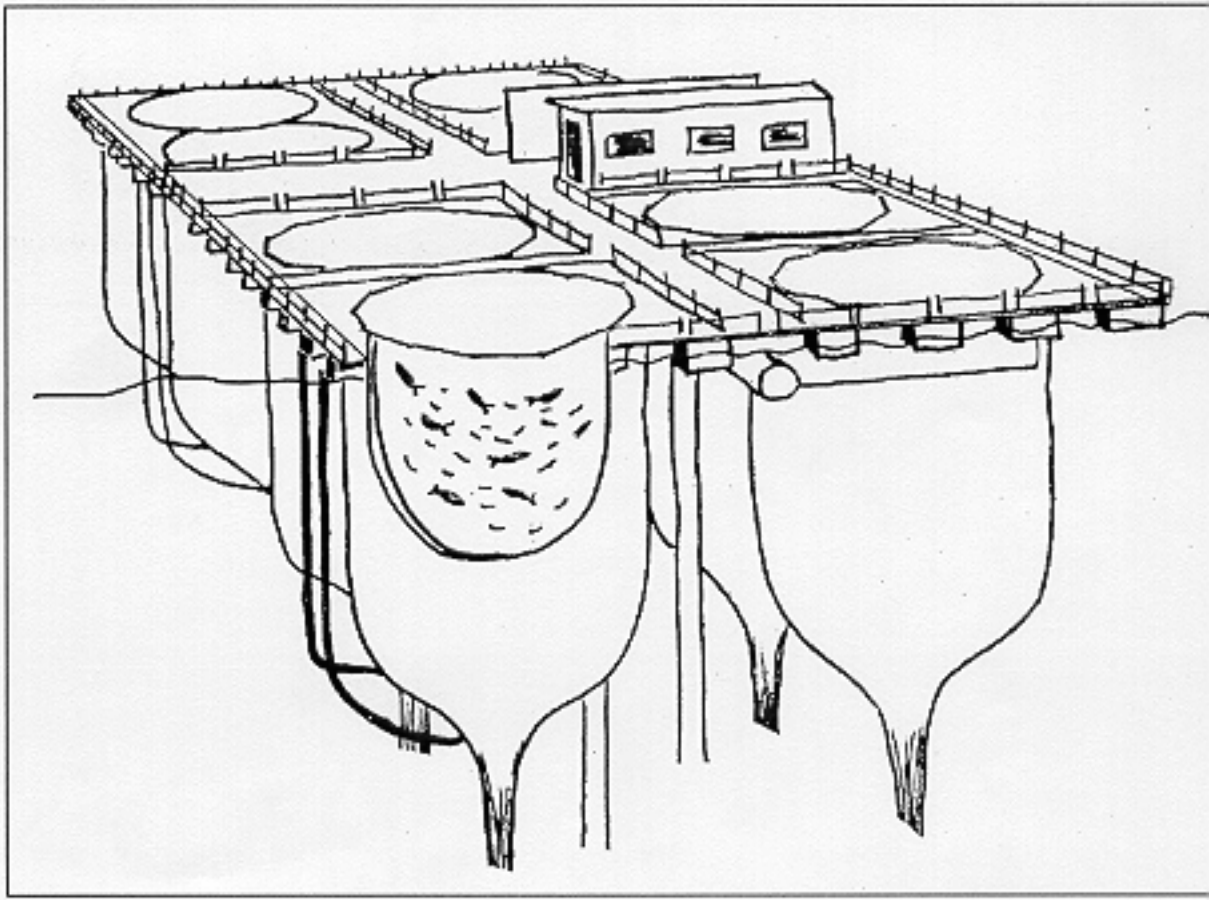
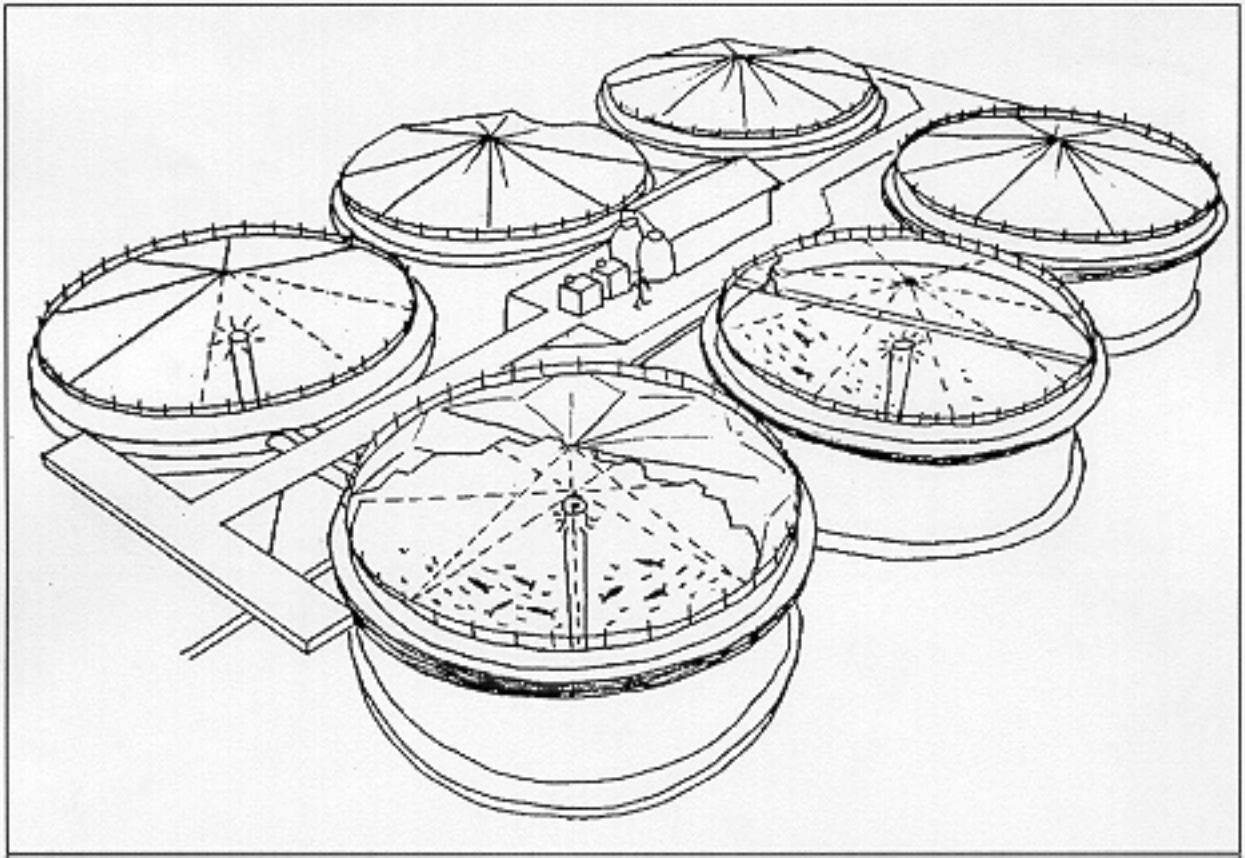


Figure 7. MariCulture Systems Sargo FinFarms design (adapted from MariCulture Systems, 1997).



ANNEX A: Individuals Contacted

Individual	Organization	Location
Keith Agnew	Aqua Scott Marketing Ltd.	Scotland
Bernie Bennett	Target Marine	British Columbia
Clayton Brenton	Future SEA Farms Inc.	British Columbia
Leonid Bugrov	SADCO-SHELF Ltd.	Russia
William Crow	Scottish Salmon Growers Association	Scotland
Alice Eriksen	Ocean Spar Technologies	Washington State
Bill Evans	Mariculture Systems Inc.	Washington State
Don Furnell	Malaspina College and design biologist for former Hagensburg Facility	British Columbia
Langley Gace	Ocean Spar Technologies Ltd.	Washington State
Werner Gaus	MEGA FISCH	Germany
Ward Griffoen	West Coast Fishculture	British Columbia
Jorgin Gunnarsson	**Akva-Trade Ltd.**	**Norway**
Chris Hempleman	Otterferry Ltd.	Scotland
Lars Henriksson	Norditrade Ltd.	Ontario
Jonas Jonasson	Iceland Fish Farmers and Sea Rangers Association	Iceland
Gary Loverich	Ocean Spar Technologies Ltd.	Washington State
Dave Mallinson	Dunlop Aquaculture	England
Bill Miller	Landcatch Ltd.	Scotland
Mike Mulholland	AquaSure Systems Limited	British Columbia
Omno Osnrnd	Norwegian Directory of Fishery	Norway
Martin Waterhouse	Landcatch Ltd.	Scotland
Graham Willaby	Intensive Aquaculture Technology Ltd.	Scotland
Bob	**Bo**	

ANNEX B: TARGET QUESTIONS FOR INFORMATION COLLECTION

The following is a listing of the target questions which were formulated at the initiation of the information collection stage for the generation of this report. The purpose of setting 'target questions' was to ensure that the objectives as previously outlined were achieved. Not all questions were applicable to all technologies. Answers to all the questions for each alternative technology were sought, but not always found. Answers were at times specific to particular siting circumstances, and thus generalizations not always possible. Nonetheless, the questions provided a consistent and workable framework from which to explore the issues.

Box b.1. Target questions for information collection.

1. Is this technology for saltwater grow-out?Describe the general design of the system and its use.
2. What is the intent of developing and/or using this system and what benefits does it represent over traditional marine net-cage use?
3. What is the current state of development and what are the future prospects (i.e., technical and economic feasibility)?How many facilities are operating?Are they operating as research facilities or for commercial purposes?Could/does the facility operate profitably and how does this relate to cost of production (e.g., $/kg fish produced) or inventory losses (e.g., survivability of fish) over traditional marine net-cage use?What is the maximum stocking density with this system?What are the start-up capital requirements?
4. What are the overall environmental impacts compared with traditional marine net-cage use?Describe the water flow and treatment.Is water flow recirculating and/or flow through?How are nitrogenous wastes treated (e.g., biofilters)?How is disinfection achieved (e.g., UV/ozonation)?Is oxygenation used? Level?How are solid wastes handled?What are the energy/electricity requirements?
5. What are the specific siting requirements?
6. Do you have a contingency plan for system failure?
7. Do you know of other alternative technologies being developed?
8. General comments?

ANNEX C:
Preliminary Process Design and Cost Estimate for a Land Based Salmonid Rearing Facility Located in Coastal British Columbia