

SCOMM

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Salmon Farming in Alaska
Economic Feasibility and Socioeconomic Impacts

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April, 1987 .

Introduction

1) Overview

The dramatic increases in production of farmed Atlantic salmon has resulted in both optimism and fear for Alaskans. The optimism is expressed by those who believe salmon farming presents an alternative source of employment and income for the state. The fear is expressed by those who believe that farmed Atlantic salmon will compete with wild Pacific salmon in the marketplace, and cause reductions in employment and income for the traditional fishery.

The focal point for both groups is whether salmon farming should be legalized in the state of Alaska. (More precisely, whether the defacto restriction on production through the limitation on smolt acquisition is to be lifted.)¹ As with any public policy, the economic costs and benefits must be weighed in order to make a rational decision. The purpose of this piece is to aid in that process.

There would seem to be three important questions in this issue. The first is whether salmon farming is feasible in Alaska. If not, all arguments are moot because salmon farming wouldn't occur even if legal. If it is feasible, what kind of employment and income can we expect this industry to generate (both in terms of numbers and in terms

¹ See "Aquaculture in Alaska" for a discussion of the legal issues.

of demographics)? Finally, what affect will the development of this industry have on the traditional fishery?

The central focus of this piece is a comparison of two scenarios - one with and one without Alaskan salmon farming. It is necessary to make this comparison with the recognition that world output of farmed salmon is expected to be much higher in the future. Thus an investigation of the impact worldwide production will have on the traditional fishery must be made first. A discussion of the incremental effects Alaskan salmon farming will have can then be made.

It would be a major error to confuse the two points above. There is nothing Alaska can do to prevent the affects worldwide production will have on the traditional fishery. That is, preventing salmon farming here will not change this. These effects should not be a part of the decision to legalize salmon farming. The main concern should be the incremental effects of Alaska's own production.

The last question may be the one with the most public controversy. There is argument about the degree to which Atlantic and Pacific (and fresh or frozen) salmon compete in the marketplace. This is a vital ingredient in discussing the effects of farmed salmon on the traditional fisheries. The view taken here is that it is better to be conservative and provide a margin of safety - to assume that the species do compete directly in order to estimate spillover affects.

Even with this conservative (pessimistic) approach, it appears that Alaskan salmon farming will largely complement, rather than displace the traditional fishery. The increases in world production are likely to have significant effects on the Alaskan traditional fishery. However, incremental Alaskan production is likely to have only marginal effects on the Alaskan traditional fishery.

Salmon farming is likely to generate thousands of jobs, and hundreds of millions in sales dollars when both direct and indirect effects are considered. The industry should earn high marks in terms opportunities for rural Alaskans. If the industry is developed properly, it will provide opportunities for family run operations as in Norway. Finally, it is an industry that provides year round employment and will result in wage dollars being spent in Alaska rather than elsewhere.

2) Putting Things Into Perspective

Before the technical analysis begins, a brief look at the relevant markets is warranted in order to put salmon farming into perspective. There has been an enormous increase in the production of farmed salmon. 1985 farmed salmon production (Atlantic and Pacific) was approximately 267% larger than 1981 production. Output increased from 12,000 metric tons to 44,000 metric tons over this period. However, as a fraction of total world salmon production, or even total world premium (Coho, Chinook, and Sockeye) salmon, the change is much less dramatic.

Table one indicates total wild, farmed, premium, and aggregated output numbers for various years. Note that even under the fairly dramatic forecasts of 142,000 metric tons of farmed salmon production by 1990, this represents only 17% of estimated world production. Currently, less than 10% of the world salmon supply is coming from farmed sources.

The above may underestimate the magnitude of farmed salmon relative to its particular market. Farmed production is sold as a fresh premium product. It may be appropriate to compare pen-raised output with wild Coho, Chinook, and Sockeye landings. Here, the comparison is more dramatic. If one thinks of these species as comprising a particular market segment, farmed production will rocket to over 40% of premium salmon production by 1990.

Thus, the dramatic increases in farmed salmon production do represent a substantial increase in the world supply of premium salmon species. The impact this will have on Alaska depends on how the demand for salmon changes through 1990. This topic is addressed after a brief discussion of salmon farming's feasibility in Alaska.

Relative Size of Salmon Farming

<u>Year</u>	<u>Wild</u> <u>Total</u>	<u>Farmed</u> <u>Total</u>	<u>Farmed+Wild</u> <u>Total</u>	<u>% of</u> <u>Total</u>	<u>Premium</u> <u>Wild</u>	<u>Premium</u> <u>Total</u>	<u>% of</u> <u>Prem</u>
1983	670.7	23.4	694.1	3.4%	196.4	219.8	10.6%
1986	657.0	59.2	716.2	8.3%	200.3	259.5	29.0%
1990	677.0	142.0	819.0	17.3%	200.0	342.0	41.5%

Table 1

Sources: 1983 and 1986 Wild and Farmed total figures reprinted from "World Markets for Farmed Salmon, p 2. 1990 farmed projections from "Aquaculture in Alaska" p 55. Premium wild species (Chinook, Coho, Sockeye) from "Statistical Yearbook - North Pacific Commission, 1986" p 15. (1986 estimates). Wild production of premium species assumed constant through 1990.

Conclusion

The already dramatic increases in the production of farmed Atlantic salmon force Alaska into a decision. Should salmon farming be legalized here? This project has attempted to answer the question through a socio-economic impact analysis. This is certainly not the only important point of view. Equally important are the biological issues that have been raised, and these should be considered as well.

It appears that salmon farming will be profitable in Alaska. A transportation cost advantage to Japanese, Canadian, and U.S. markets offsets higher feed and labor costs on the farm itself. Alaska has innumerable site possibilities. The infrastructure and labor force are already compatible with such an industry.

The industry does not appear to have dramatic scale economies. Rather, farms with one manager and a small crew seem to be the most profitable. The Norwegians have built a substantial fishery based on these small rural operations. There is no reason why Alaska should expect much difference. While much of the capital may initially come from outside, the same is true for virtually every significant industry this state has developed.

If this state does allow salmon farming, it appears that even a very modest development will result in thousands of jobs (part time plus full time), and over one hundred

million in sales dollars when both direct and indirect effects are considered. The 20,000 metric ton scenario resulted in well over \$300 million in final sales, around \$90 million in final payroll, and over 4,000 in final employment.

The numbers are promising largely because second round effects are substantial. This is an industry that provides stable employment and pays year round wages - much of which will be respent within the state rather than outside.

There has been argument about the degree to which wild Alaskan salmon (both fresh and frozen) compete with the farmed Atlantic and Pacific salmon product. This is indeed the key in calculating the spillover affects of salmon farming on the traditional fishery. This study took a rather pessimistic approach, and assumed direct competition between farmed and wild products. In this way, the maximum feasible impacts may be calculated.

It was shown that the traditional fishery has reason to be concerned with the increases in worldwide production. The worst case scenario indicated a \$36.4 million loss to the fishery through reduced revenues. However, incremental Alaskan production only added another \$4.7 million loss on top of this. The gain from the development of the industry here was \$132 million in direct sales, and the final effects listed above.

Note that these figures are the result of some very pessimistic assumptions - that demand for salmon fails to

increase over time (in conflict with recent experience); that farmed and wild salmon compete directly (also in conflict with recent experience); that the enormous projected increases in world production in fact occur. For these and other reasons discussed in the text, these numbers are substantial overestimates of the effects world and Alaskan salmon farming will have on the traditional fishery.

This is not to say that salmon farming will not affect the traditional fishery. World salmon farming probably does mean millions of dollars in reduced revenue to the traditional fishery over the long run. In particular, technological and genetic improvements will make salmon farming an ever more efficient enterprise. The crucial point Alaska policymakers must not miss is that as salmon markets become larger and more competitive, the effect of one's own production on market price becomes ever smaller.

Therefore, the issue of salmon farming in Alaska involves a choice between two futures: One is a future without salmon farming, but with a permanently lower level of employment and income in the fishery and the state as a whole. The other is a future with salmon farming, and with a higher level of employment and income in the fisheries sector as well as the state as a whole.

Alaska Mariculture Association

TO: All Legislators

FROM: Rodger Painter
Executive Director

DATE: March 17, 1989

RE: Finfish Farming Impacts on Wild Salmon

As hearings open on legislation to authorize finfish farming when the moratorium expires in 1990 (Senate Bill 195), it might be useful to review some recent information examining the impacts of the pen-rearing of salmon on wild stocks and the environment.

Attached you will find a news release describing the findings of a comprehensive draft environmental impact statement on the effects of pen rearing on wild stocks and the environment. The Washington State study was more than a year in the making and represents the most thorough examination of its kind.

Significantly, this study supports the earlier conclusions of the Alaska Departments of Fish and Game and Environmental Conservation that the problems associated with salmon farming are manageable with proper controls, siting guidelines and funding.

Sen. Bettye Fahrenkamp's office has made some copies of the EIS and accompanying technical appendices for distribution to interested legislators.

I also have attached an article I prepared recently addressing disease and genetics concerns. I would be pleased to furnish copies of the Norwegian studies referenced in the articles at your request. I have additional information and am available to discuss these issues with you or your staffs.

The current debate over disease and genetics is very reminiscent of the opposition raised to our currently hatchery program when it was first proposed. Many of the same kind of concerns now raised about salmon farming were voiced then by fishermen opposed to hatchery release programs.

The very conservative management and resulting success of these programs have convinced most fishermen that aquaculture is an extremely valuable biological tool offering great economic benefits. The Alaska Mariculture Association agrees and merely wants to take our existing program to its logical next step, slowly and carefully.

Thank you for your attention to this important issue.

Alaska Mariculture Association

FOR IMMEDIATE RELEASE

Major Study Shows Minimal Impact from Fish Farming

A draft environmental impact statement prepared by the State of Washington provides Alaska with the information necessary to solve the long-standing issue of salmon farming, according to the Alaska Mariculture Association (AMA).

The document has been in the works for well over a year and represents the most comprehensive work ever performed regarding the impacts of salmon farming. Rodger Painter, executive director of AMA, said the EIS clearly provides net-pen rearing of salmon with a clean bill of health.

Washington has been undergoing a debate over the net-pen rearing of salmon similar to the one occurring in Alaska over the past several years. The draft EIS published in late January was ordered by the Washington legislature to evaluate the environmental impacts of net pens on the biological and human environments.

According to the document summary, these are the major conclusions of the draft EIS:

1. The major impacts of net-pen culture can be prevented by proper farm siting to assure dispersion of wastes, flushing of the site, and protection of sensitive areas.
2. The impacts of net pens are reversible, and after pen removal any affected areas will revert to their undisturbed state.
3. The accidental introduction of an exotic disease into state waters remains a risk. While existing import rules minimize this risk, it cannot be eliminated if animals are to be introduced from other areas.
4. Four levels of development were analyzed. Proper siting of 100 farms would not have a significant impact on the aquatic environment; however, small bays may be adversely affected by over-development.

"The EIS suggests that the net-pen rearing of salmon would pose no significant threat to Alaska's natural salmon runs or to the

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environment," Painter said. "It is our hope that legislators, state agencies and critics of salmon farming closely study this document to determine what additional questions must be answered before Alaska can proceed forward with the most significant economic development opportunity available for the asking.

"There have been several questions being raised consistently during the debate over salmon farming in Alaska regarding impacts on wild stocks and the environment," Painter said. "These include the risk of spreading disease from farmed fish to wild stocks, genetic dilution of wild stocks from escaped pen-reared salmon, degradation of the environment, and impacts from the use of antibiotics.

"These issues are discussed in detail in the draft EIS, and salmon farming passes all four tests with flying colors." Painter provided these excerpts from the EIS as examples:

Disease--"Review of the technical literature indicates the risk of transmission of disease from net pens to wild fish is possible but is not likely a significant problem. Fish disease control regulations...are in place in Washington to prevent the importation of exotic infectious diseases. It is such diseases which could pose a significant risk to native fish."

Painter said it is significant to note that Washington allows the importation of Atlantic salmon and other non-indigenous stocks for use in salmon farms, while AMA supports the state's current ban on Atlantic salmon and prohibitions against the use of non-Alaska salmon stocks.

Escaped Salmon--"Assessing the potential impact of farmed Pacific salmon or steelhead on wild populations is difficult given the speculative nature of the issue. Local experts agree that significant genetic impacts of wild populations due to widespread net-pen farming in Puget Sound is unlikely. The most likely scenario for an impact would be where large numbers of genetically different escapees ascended a stream with a relatively small wild population. The impacts to the wild population, if any, would be reduced fitness of the interbred progeny. Without constant infusion by escaped fish, these maladaptive genes would disappear gradually due to selective pressure, making any impacts temporary. Compared with the large numbers of hatchery releases, the genetic impact of escaped farmed fish on wild stocks would be negligible."

Water Quality/Antibiotics--"Net-pen aquaculture can potentially have a wide range of impacts on water quality. Some water quality determinants such as temperature, pH, fecal coliforms and toxicity are virtually unaffected by net pens. Other determinants are affected only during some periodic activities in the operation of net pens. This is the case of turbidity which may be impaired during net cleaning.

"The primary water quality indicators of concern are dissolved

oxygen, nutrients, and antibiotics. Nutrients are a concern in certain nutrient sensitive embayments where they potentially cause large increases in phytoplankton populations and possibly causing nuisance algal species. Dissolved oxygen and nutrient impacts are usually very localized in the immediate vicinity of a net pen and decrease rapidly with distance away from the pens due to diffusion and biological activity. Antibiotics have not been shown to cause the development of antibiotic resistant bacteria except in highly controlled laboratory experiments. The development of antibiotic resistant bacteria in Puget Sound is virtually impossible at the low temperature and low concentrations of antibiotics around net pens in the Sound."

"Mitigation measures are capable of reducing or eliminating all adverse water quality impacts from net pens."

The study provides the information necessary for Alaska to make informed decisions regarding salmon farming, Painter said. "This EIS confirms the position taken by our state agencies in the past that the impacts of salmon farming are manageable. It is our hope that we can now proceed forward with an informed debate about what Alaska's policies should be regarding a significant opportunity for economic diversification.

"AMA has been advocating a careful approach to development of salmon farming in Alaska. This study says it is very possible to proceed forward with a minimal adverse impact. It is time for state policymakers to stop ducking the issue, and go about setting a careful, intelligent state policy on fish farming."

Alaska imposed a one-year moratorium on commercial finfish farming in 1987. That moratorium was extended for two years in 1988, and is scheduled to lapse on July 1, 1990. A task force to study the issue was not funded, and virtually no progress has been made to resolve the issue over the past several years.

A small commercial freshwater salmon farm was established in Fairbanks under a narrow exception to the moratorium. A joint federal-state salmon farming research project in Southeast has demonstrated the biological viability of net pen rearing of salmon in Alaska.

Two independent studies for the state released in 1988 showed that Alaska salmon farms could be competitive in world markets and would have a minor impact on world salmon markets.

A major private study in 1985 concluded that a modest salmon farming industry in Alaska could produce 2,640 direct and indirect jobs and a payroll of \$67.8 million on total sales of \$132 million. A subsequent legislative study calculated a more modest impact of 1,920 new jobs (direct and indirect) and a payroll of \$48.8 million.

Alaska Mariculture Association

FOR IMMEDIATE RELEASE

Finfish Farming Does Not Threaten Wild Salmon

by Rodger Painter, Executive Director
Alaska Mariculture Association

In the heated debate over finfish farming, it often is difficult to have a calm, factual discussion of complex technical issues like disease and genetics. In the midst of charges and countercharges, attention tends to get focused on the most sensational aspects of the debate, and analytical reports of scientists and researchers don't make for very interesting copy.

In light of continued efforts of critics to describe salmon farming as something akin to introducing AIDS into our marine environment, it is important to review what more dispassionate voices, such as the scientific community, have to say.

The reaction of salmon farming critics to the recent discovery of a dangerous, exotic fish disease in Washington State was swift and predictable--it must have been caused by fish farming. However, that allegation is disputed by federal and state officials investigating the outbreak of VHS (viral hemorrhagic septicemia). Officials have stressed there is no evidence linking farmed salmon with the disease outbreak.

The disease was isolated in adult Pacific salmon returning to two Washington hatcheries located some 75 miles apart. Alaska's chief fisheries pathologist told the legislature recently that scientists are baffled by the appearance of VHS in North America, and that there are three suspected sources: (1) ballast water discharged from foreign ships; (2) infection from marine fish (cod, halibut, etc.); and (3) imported fish stocks. A Washington disease expert also said VHS may have been present in the environment for years without detection.

Lost in the media coverage and absent in statements by those attempting to link VHS to Washington Atlantic salmon farms were the following facts: (1) Atlantic salmon eggs imported into Washington were certified as VHS-free after intense scrutiny; (2) the European hatcheries supplying the eggs to Washington have never been infected with VHS; (3) fisheries scientists say VHS is not transmitted through eggs; and (4) VHS has never been detected in Atlantic salmon stocks in the wild, hatcheries or farms.

One of the most sensational recent allegations leveled against salmon farming is that the industry has destroyed 30 wild salmon

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rivers in Norway. The claim, made recently by the United Fishermen of Alaska's Mariculture Committee, conflicts with the research state and university officials have gathered on the Norwegian experience. UFA charged that a "fish farm disease" that "has destroyed 30 wild salmon rivers in Norway is Gryodctylus salarius, a parasite that entered Norway via infected smolts from Sweden."

While two studies by the Norwegian Directorate for Nature Management obtained by the University of Alaska Marine Advisory Program trace the introduction of this parasite to Atlantic salmon stocks imported from Sweden, researchers say the disease was spread by "river stocking programs." The studies say other rivers were infected by fish traveling from one stream to another through brackish waters. The situation is exacerbated by the fact that Norwegian hatcheries freely exchange eggs, fry and smolts.

The shortcomings of Norwegian control of river stocking and farm hatchery systems are underscored by the documentation of unauthorized river stocking by infected private hatcheries and sales of diseased fish for illegal releases. The parasite "is easily spread to new areas in this manner," according to one study.

The G. Salarius parasite is deadly and spreads easily. The studies say it has been found in "28 different watercourses and about 11 hatcheries in Norway." Wiping out all fish--and consequently the parasite--in some river systems with a natural compound known as Rotenone has been shown to be effective, but the studies indicate the parasite is far from under control.

The danger of this introduced parasite should not be underplayed. A third study by the Directorate for Nature Management blamed current concern over the health of Atlantic salmon runs in Norway on a combination of acid rain and spread of G. salarius. These factors, combined with rising concern over the infusion of renegade farm salmon escaping into river systems, has led to the establishment of a salmon sperm bank, the study said.

These more recent threats add to the long-standing depletion of wild salmon in Norway that can be linked to familiar problems--over-fishing, pollution and the damming of major spawning systems to produce hydroelectric power.

Information obtained by Dr. William Smoker, a geneticist with the University of Alaska Southeast, sheds some light on what Norwegian scientists have found about the effects of renegade farmed salmon. In 1988 correspondence with Smoker, Dr. Trygve Gjerdem, a leading geneticist with the Agricultural University of Norway and president of the International Association for Genetics in Aquaculture, summarized the conclusions of initial research:

So far no positive or negative effect has been found to be caused by renegade fish in wild populations.

[No research] has shown that renegade fish spawn in rivers.

No information is available whether or not renegade fish and their progeny can compete with wild fish in a river system.

Nothing in any of the scientific information collected to date suggests that fish farm-related diseases or escaped salmon have destroyed 30 Norwegian salmon streams. Norway's salmon runs have been seriously threatened for decades by a variety of factors unrelated to salmon farming.

More information on the potential effects of salmon farming can be found in a draft environmental impact statement recently released by the State of Washington. After more than a year of intensive study, the EIS came to some interesting conclusions on disease and genetics:

"Review of the technical literature indicates the risk of transmission of disease from net pens to wild fish is possible but is not likely a significant problem."

"Local experts agree that significant genetic impacts of wild populations due to widespread net-pen farming in Puget Sound is unlikely. The impacts to the wild population, if any, would be reduced fitness of the interbred progeny. Without constant infusion by escaped fish, these maladaptive genes would disappear gradually due to selective pressure, making any effects temporary. Compared with the large numbers of hatchery releases, the genetic impact of escaped farmed fish on wild stocks would be negligible."

This information does not mean that the concern expressed by commercial fishermen over the disease and genetic issues related to salmon farming are unfounded. These are issues which should be of primary concern to fishermen, and other dependent upon the seafood industry.

The Alaska Mariculture Association believes in a conservative approach to development of fish farming, and we have consistently supported bans on importation of non-indigenous species and strong statutory controls by the Alaska Department of Fish and Game over private farms and hatcheries.

We believe that salmon farming can be every bit as safe as Alaska's highly successful ocean ranching program if it is approached in this conservative fashion. Disease and genetics are important issues that must be thoroughly investigated and debated, and we welcome the opening of an improved dialogue.

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Rodger Painter is a sixth generation Alaskan who grew up on the fishing grounds and currently is executive director of the Alaska Mariculture Association.

MY TURN

Seeking a solution to the fish farming debate

By Sen. ARLISS STURGULEWSKI

The development of Alaska's natural resources traditionally sparks spirited discussions. This can be a healthy process where issues such as costs and benefits, protection of the environment and resource values, public health and safety, and other important public policy issues are thoroughly explored.

Sometimes these debates reach the point of impasse and the public policy issues tend to become obscured in the overheated rhetoric of proponents and opponents moving further apart. Hopefully, we have not yet reached that point in discussions over mariculture development.

The recent introduction of legislation by the Senate Resources Committee authorizing finfish farming in Alaska has reopened debate over an important policy left hanging far too long. Committee hearings on finfish farming are scheduled to begin soon, and it is hoped that some constructive dialogue will take place.

This is a complicated, controversial issue that has split the legislature, and resulted in the unusual imposition of a moratorium on a promising economic opportunity. The farming of salmon and other finfish is a major growth industry throughout the world, and Alaska's potential is great.

A recent report by the American

Embassy in Chile provided a dramatic picture of how a struggling rural economy has benefitted from the growth of salmon farming:

"Experts foresee that salmon aquaculture could grow to 25,000 tons by 1990, equating at current prices to more than \$100 million (U.S.) Two thousand workers and professionals are currently involved in aquaculture activities. Unemployment declines where salmon producing activity starts."

Salmon farming in Alaska may never grow this quickly or even reach the 1990 projection for Chile, but it's clear that even a modest, carefully developed industry could provide a significant boost to our struggling private sector. Beyond replicating what other countries have done with the farming of chinook and coho salmon, Alaska has the opportunity to stake out unique niches by farming sockeye salmon, arctic char, sheefish, black cod and other promising aquaculture candidates.

Alaska's important fisheries resources and healthy aquatic environment must be protected under whatever development scenario we finally elect. After closely studying this issue for the past three years and personally investigating fish farms in Canada and Puget Sound, I really believe that it is possible to develop a viable finfish farming in Alaska

without damaging our fisheries resources or environment.

This view is supported by a recent comprehensive environmental impact statement on salmon farming conducted by the state of Washington. Among the conclusions of this in-depth study were several of great importance to Alaska:

- "...The risk of transmission of disease is possible but not likely a significant problem."

- "Local experts agree that significant genetic impacts of wild populations due to widespread net-pen farming is unlikely."

- "The major impacts of net-pen culture can be prevented by proper farm siting to assure dispersion of wastes, flushing of the site, and protection of sensitive areas."

- "Proper siting of 100 farms would not have a significant impact on the aquatic environment; however, small bays may be adversely affected by over-development."

An attached cost-benefit analysis of salmon farming by the Washington Department of Fisheries concluded: "...Washington's economy would, in any event, benefit from further growth in fish farming, and that it may benefit substantially."

This EIS and a growing collection of additional data provides the legislature with the information necessary to set an informed public policy

regarding fish farming. In the coming weeks the Senate Resources Committee will be going over this information, listening to the public and other experts, and reviewing agency testimony regarding finfish farming.

The committee may indeed find it necessary to work throughout the interim on the issue to produce a carefully crafted piece of legislation. We must meet a self-imposed deadline of July 1, 1990, when a three-year moratorium on finfish farming expires.

Our challenge over the next few months will be to pull all Alaskans together in a constructive dialogue. We must focus on the ultimate goal of enhancing Alaska's competitive position in world seafood markets and not get sidetracked by short-term political considerations. This requires a rational, dispassionate analysis of the public policy issues.

Finfish farming represents one of the few opportunities for private sector-driven economic development available to Alaska for the asking. Let's not end up squabbling among ourselves while the rest of the world leaves us behind.

Sen. Arliss Sturgulewski, R-Anchorage, is chairman of the Senate Rules Committee and a member of the Senate Resources Committee and the Senate Special Committee on High Seas Salmon Interception.

STATE OF ALASKA

DEPARTMENT OF COMMERCE & ECONOMIC DEVELOPMENT

DIVISION OF BUSINESS DEVELOPMENT

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FROM: Paul Peyton, *Paul* Project Manager
Division of Business Development
Department of Commerce & Economic
Development

SUBJECT: Preliminary Findings of Socioeconomic Studies

NOTE: Final reports are due March 11 and these findings are presented in the interim to aid discussions. These are not complete, but should not change materially.

The Department of Commerce and Economic Development (DCED) has received preliminary reports from the contractors working on the cost of production model and salmon market model. In addition, staff met with the contractors to go over the results to date and to evaluate the probable work products and timing of results.

Meetings were also arranged with several marketers of troll and farmed products, including Barry Lester, President of the Alaska Troll Salmon Producers Association, and Arnie Einmo of Dory Seafoods, a major broker of B.C., Chilean, and Norwegian salmon in Seattle. They were asked to provide input and critique the work done by others to assist in evaluating the reliability of the results.

The study topics, as related in the department's earlier memo to interested parties, were chosen to answer the maximum number of questions posed by the resource committees with the monies available. Those questions focused on the economic feasibility and ex-vessel price impacts of pen rearing salmon in Alaska. In addition, questions as to industry structure, location, and participants were posed. As these were in large part dependent on the basic feasibility and funding was not adequate to do an in-depth analysis of those questions, the Fisheries Cabinet elected to answer the feasibility and price impact questions first.

Attached are copies of the letters from the contractors, a review of the B.C. industry for 1987 by DPA Group, Inc., and excerpts from a study done by DPA Group, Inc. and Dr. Anderson in 1987 for the B.C. Salmon Farmers Association which analyzes the market for farmed salmon. That report concludes that the North American market has the best potential for B.C. farmed fish, and most of the study is directed at analyzing that market.

While this last study does not answer many of the questions concerning Alaska's potential entry into pen rearing, it does help put in perspective the world supplies and markets for pen reared fish, and B.C.'s strategy for selling their product in the U.S. Many of the same observations can be applied in analyzing Alaska's potential as a pen rearing area. This document is being reviewed by various marketers of troll and pen reared production, and we will report on their evaluation. To date none have found any serious cause for disagreement.

That study did not, however, address the Japanese market in any detail. A major focus of the study underway by DCED is to evaluate the market in Japan, and to refine the information on west coast U.S. markets. The other major effort will be in price forecasting, something DPA Group, Inc.'s study did not do in any detail.

Based on results to date, the contractor feels it should be possible to:

1. Evaluate in general terms the extent to which potential Alaskan farmed salmon would compete with Alaskan wild production in likely markets for Alaskan farmed salmon -- Japan and the west coast of the U.S.
2. Gauge the relative impact of Alaska's increment of potential production on wholesale salmon prices. As the funds are not adequate to build a worldwide supply and demand model, it is not possible to predict with certainty the overall effect of world production on markets for Alaskan wild salmon.
3. In the near term, predict what will be the actual market prices for farmed salmon potentially produced in Alaska. A point estimate for 1995 will be produced and, if possible, high and low bounds will also be determined.

The contractors have both had trouble obtaining some data and requested one week extensions, to March 11, for the final report. Given the complexity of the issues, they were in turn asked to be available to present the findings to the legislative committees. They have agreed. Dates will need to be determined.

The department is holding approximately \$4.0 in reserve to address questions that arise after the costs and markets have been addressed. An overall evaluation of the positive and negative impacts might be undertaken, for example.

SUMMARY OF SIGNIFICANT FINDINGS TO DATE

WILD PRODUCTION OF KINGS AND COHOS

1976-86 average king + coho	70,000 mt
all gear types	
West Coast, B.C., and Alaska	

Source: Compilation of NMFS and ADF&G data.

NOTE: The production is increasing with ocean ranching and conservation measures taking effect. Estimates of this increase are being prepared by the contractors.

WORLD SUPPLY AND DEMAND FOR ALL FROZEN AND FRESH SALMON

Total world consumption of fresh and frozen salmon including all species and all sources in 1984.

Japan	273,600
United States	52,700
Canada	12,100
Europe	
France	21,100
U.K.	10,600
Other	18,300
Total	388,400

Total world production of salmon by species in 1983.

Atlantic Wild	7,518	1%
Farmed	17,795	3%
Pacific (Wild)		
Chinook	19,784	3%
Coho	34,445	5%
Sockeye	164,000	24%
Chum	188,850	27%
Pink	252,830	37%
Masu (Cherry)	3,300	-
Total All Salmon	688,522	100%

Note: Figures are from UN Food and Agriculture Organization.

Source: DPA Group, Inc. Market Access and Penetration Strategy

PROJECTED WORLD PRODUCTION OF FARMED SALMON BY 1990

Atlantic	150,000 mt
Pacific	35,000 mt
Projected Increase in Supply to U.S.	49,400 mt

Projected Increase in U.S. Demand 47,000 mt
at current prices

Conclusion - "This result suggests that the forecasted supply of salmon to the U.S. market until 1990 could be absorbed by the market at current prices, provided no supply and distribution constraints exist In reality, average real prices for farmed salmon likely will continue to decline until 1990 but not greater than 25-30% below current prices Production efficiencies in regions like Norway and Chile are improving, and increasing competition is forcing producers to reduce the fairly healthy profit margins they have enjoyed to date."

Source: Market Access and Penetration Strategy - DPA Group, Inc.

FARMED SALMON PRICES IN U.S. (AVERAGE)

Atlantics 4-6 lb.	1986 \$3.85	1987 4.60	Jan 5.50	Feb
Pacific Salmon 4-6 lb.				
Coho, Chile		\$3.83	4.20	3.65*
Canada		\$3.59		
King		\$4.04		

Source: Seafare Group, Preliminary findings

* Seattle price during large scale promotion at \$4.99/lb. retail. Fish did not sell well and price dropped from \$4.20 to \$3.65 as distributors dumped their inventories.

OBSERVATIONS CONCERNING 1987 PRICE MOVEMENTS

A disease (hitra) outbreak in Norway in late 1986 led to a surplus of farmed salmon early in 1987 as vulnerable fish were harvested early, and to a shortage later. This shortage was compounded by a poor harvest of wild cohos, resulting in unusually high prices for farmed and wild salmon in 1987 (and high prices for Alaskan fishermen). The prices of both Norwegian and Alaskan salmon can be expected to come down again as production picks up.

Source: Barry Lester, SPC Sales Manager

NOTES ON THE EUROPEAN MARKETS

It should be noted that the European market for Alaskan salmon seems to be holding up in terms of volume due to the decades old relationship between Alaskan suppliers and their markets, primarily smokers, and the price and product attributes of wild Pacific salmon - lower price, firmer flesh, redder color, larger sizes. Market share is declining, however, as the market expands, and the overall supply of

both wild and farmed fish determines the price. The long-term trend is probably for continued sales volume, but lower price and eroding market share.

The European market is very important for troll and high quality net kings and cohos. The Norwegians and Scots are also starting to smoke fish for export to these markets in direct competition with the buyers of Alaskan salmon. Major efforts are underway by ASMI to promote Alaskan salmon there using Federal monies.

Source: Combination of Market Access and Penetration Strategy by DPA Group, Inc., and data in ASMI TEA application concerning sales volumes, corroborated in discussions with several major brokers.

FRESH MARKETS FOR WILD PACIFIC SALMON

Currently, much of the Washington, Oregon, and California king and coho production is marketed fresh in the restaurant, fish shop and retail trades. The large majority of fresh kings and cohos marketed in the U.S. come from these sources. Only 10% or less of Alaskan king and coho production is sold fresh due to higher margins available in the frozen markets and the difficulties of getting fresh product out of Alaska in volume.

Source: Seafare Group, personal communication, corroborated by various Alaska producers.

COSTS OF PRODUCTION FOR FARMED SALMON

Estimated total costs of production		FOB Farm	FOB U.S. LA	Port NY
B.C. 1987	\$5 Cdn/kg =	\$1.70 U.S./lb.	\$1.95	\$2.75
Norway 1984	\$31 Kr/kg =	\$1.56 U.S./lb.		
at current exch rate		\$2.22 U.S./lb.	3.37	3.02
Washington 1987		\$2.05 U.S./lb.	2.10	2.75
Scotland 1985	3.20UKL/kg =	\$1.94 U.S./lb.		
at 1987 exch rate		\$2.66 U.S./lb.	?	?

Sources: B.C. - DPA Group, Inc. Overview of the B.C. Salmon Farming Industry
 Norway - Norwegian Directorate of Fisheries, Study of Profitability of Fish Farms
 Washington - Seafood Leader, Winter 1987 "Farming Washington's Inland Sea"
 Scotland - Highlands and Islands Development Board From "Atlantic Salmon Farming Industry: Past Performance and Future Potential" by Irish Sea Fisheries Board Oct. 1985

NOTES ON LIKELY EFFECT OF INCREASED PRODUCTION AND PRICE DECLINES ON
MARKETING STRATEGY OF FARMING INDUSTRY

"There appear to be few feasible market opportunities for B.C. farmed salmon other than in fresh form. At current costs of production, expected prices for farmed product as a frozen, canned, smoked, or further processed product would not yield sufficient net returns to be a viable option over the long run

Much of the value inherent in farmed fish is lost if it is sold in any product form other than fresh. As a frozen or canned product, it is unlikely to receive prices better than those prevailing for wild product

Less than top quality farmed product can be sold as fresh, frozen, or higher value-added processed form (e.g., smoked, pate product) A scarred fish exterior or extensive scale loss may be acceptable if the fish is going to be steaked or filleted."

Source: Market Access and Penetration Strategy, DPA Group, Inc.,
pg. 6-7.

PRODUCERS CAN BE EXPECTED TO DEVELOP VALUE ADDED LINES

Some Norwegian and Scottish salmon farming companies are building smokers in European countries and marketing their fish as finished product -- Barry Lester, Troll Producers Association

"Norwegian producers are finally offering their farmed salmon in forms other than the traditional whole, dressed, head-on. U.S. buyers have been clamoring for more frozen salmon and more convenient forms for years. This summer Frionor complied, bringing out a new line of frozen sides and loins The move to portions will allow Norwegian producers to increase exports without straining an already overburdened airline system that hauls thousands of tons of fresh salmon to the U.S. each year

Meanwhile, Alaskan salmon producers (who introduced frozen steaks and loins several years ago) are readjusting market strategies in the face of an unexpectedly low harvest." Seafood Business, November/December 1987, pg. 66.

Norwegian and Chilean salmon farmers can be expected to produce fillets and steaks from lower quality or small fish in particular as competition heats up and freight costs become more important in determining profitability. Both producers are far from the North American market and shipping heads and backbones that far is expensive. Overall, the price of head-on fresh Norwegian fish may drop about a dollar by the early 1990's. The price difference between Norwegian and B.C. fish will not hold up. Arnie Einmo, Dory Seafoods personal communication.

ALASKA'S COMPETITIVE POSITION

Water temperatures affect fish growth rates quite markedly. The optimum temperature range for salmon growout is 10-15° C. Water temperatures in areas of Alaska with large amounts of glacial runoff have colder summer water temperatures compared to areas with a more oceanic character, such as the outer coast of Southeast Alaska, outer Prince William Sound, Kodiak, and the Alaska Peninsula. Areas such as inner Prince William Sound, northern and eastern Southeast Alaska, and to some extent central Southeast Alaska, are at the lower end of the range.

Winter temperatures of colder than 4° C are considered poor for growing conditions, while 5-7° is medium, and greater than 7° is best. Areas close to the mainland such as inner Prince William Sound, upper Cook Inlet, and eastern and northern Southeast Alaska have winter water temperatures in the 2-4° range. More oceanic areas have temperatures in the 4-5° range. While techniques such as upwelling can be used to raise the temperature, this would also increase the costs.

Areas that have significant ice accumulation in the winter are not likely to be either warm enough or suitable from an engineering standpoint.

There are many other factors that affect the suitability of a site. While temperature is the most important factor in determining growth rates, other factors affecting mortality, such as algal blooms, are less common in colder waters. Evaluating the suitability of a site requires looking at quite a few factors. These have been surveyed in B.C. and that information is available. However, how the various factors affect economic viability has not been fully analyzed.

Source: Biophysical Criteria for Siting Salmon Farms in British Columbia, B.C. Ministry of Agriculture and Fisheries.

EXCHANGE RATES

Perhaps the most important factor affecting prices for both farmed and wild salmon is the strength of the dollar. With the dollar weak, export prices for salmon from the U.S. are more favorable, but the profit margin for imported salmon is less favorable. Salmon produced and consumed in the U.S. is not directly affected except to the extent that U.S. consumers must compete with foreign consumers.

The recent decline in the dollar has cut into the profit margins of foreign farmers, and they have raised their prices as much as possible. In addition, there is currently a shortage of salmon available which has also pushed the price up. Prices to fishermen and farmer alike are quite good. A turnaround in the dollar would put U.S. farmers and fishermen at a disadvantage, and make domestic markets relatively more desirable than in the weak dollar situation.

Another complicating factor is the movement of various foreign currencies relative to the dollar. For instance, the yen has appreciated considerably more than the kroner. A table follows that lays out the recent changes in exchange rates.

BACKGROUND ON CONTRACTORS

Three contractors were selected, DPA Group, Inc. to do the cost of production model, and Seafare Group working with Dr. James Anderson of the University of Rhode Island to do the market study.

DPA Group, Inc. is a medium sized Canadian consulting firm with extensive experience in farmed salmon economics in B.C. They have done market studies, industry financing studies, feed studies, and world supply estimates for the B.C. government and industry. They have much more extensive data on the actual costs in B.C. than anyone else we could find, and B.C. is obviously more similar to Alaska in terms of environment and species than other farming regions.

Seafare Group is a Seattle consulting company that edits Seafood Leader magazine and organizes seafood expositions. They will be working with Dr. James Anderson, a recognized authority on salmon markets who has also worked with DPA Group, Inc. Dr. Anderson's work is the most definitive available on market sizes and competitive interactions between competing products. He will be building on work already done and trying to answer some of the competition and market size and price questions.

There is also a considerable body of work that has been done by the B.C. and federal governments in Canada. This includes long-term modeling work that projects the impacts of increases in wild, ranched, and farmed salmon production on prices. Through cooperating with the Canadians on studies of this type the state will gain access to some of this information, which will be of use in planning for hatcheries and salmon marketing.

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Attachment
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DISTRIBUTION:

Senate Resources Committee
House Resources Committee
Governor Cowper
Fisheries Cabinet members
United Fishermen of Alaska
Alaska Mariculture Association
Barry Lester, Alaska Troll Producers Association
Arnie Einmo, Dory Seafoods
Peter Redmayne, Seafood Leader Magazine
David Egan, DPA Group, Inc.
Dr. James Anderson, University of Rhode Island

This is a brief summary of the final report on the Costs of Production Model for Pen Rearing and World Markets for Salmon: Pen Reared Salmon Impacts.

(*Things not taken into consideration in this study are general taxes and land costs. Quote, "the economics of salmon farming in most supply regions is not well understood.")

Comparisons:

Norway

Projected to continue as world's largest producer of farmed salmon to end of century. Production of Atlantic salmon in the year 2000 is forecasted at 200,000 metric tonnes.

In 1985, there were 559 grow-out farms and by 1987 were 611 smolt producers.

There is a large number of small farms because both pen volume and ownership of multiple site farms are restricted. (Norwegian govt. is considering a 50% increase in maximum size of each farm.)

Scotland

Projected to remain second at 50,000 metric tonnes of farmed salmon in the year 2000. Plans to continue to produce Atlantic salmon.

In 1987, 126 companies operated 196 cage sites and 11 tank sites. Also 72 smolt production companies with 80 tank and 51 cage sites. Not restrictions on size or ownership exist.

In contrast to Norway, more concentration of production and more vertical integration. In 1987, 45% of production was from the largest 20 farms.

British Columbia

Projected to be third largest producer with 33,000 metric tonnes in the year 2000, 75% of which is projected to be comprised of Chinook salmon.

In 1987, 85 farms operated 115 sites. Eight smolt producers produced about 90% of production in 1987. No restrictions on size or ownership exist.

A levy was previously charged on wild salmon eggs distributed to producers. In 1988, the levy is being shifted to smolt sales, since increasingly the industry is becoming self sufficient in egg supplies.

Chile

Projected to be fourth largest at 23,000 metric tonnes. 60% is expected to be coho salmon with the balance being mostly Atlantic salmon, with only limited production of chinook salmon.

In 1986, 22 farms producing salmon and/or trout were in operation. No restrictions on size or ownership exist.

Industry is characterized by sizeable companies rather than small family operations.

Japan

Projected to be fifth with 15,000 tonnes, comprised almost entirely of coho salmon.

Production is largely at small scales and organized through cooperatives. In 1986, a total of 19 organizations operated 264 sites.

Alaska:

- Considered to be competitive from a cost stand point in all markets.
- Would be selling farmed salmon in smaller sizes than Norway, Scotland and B.C. and would compete more directly with Chile.
- Would likely be supplied by fish feed manufacturers in Wa. State or B.C. since Ak.'s reduction industry is not well developed.
- E.C. and Chile have cost advantages over Ak. in both Los Angeles and New York.
- Ak. would likely have a short window period in which to sell which would result in more direct competition with Chileans.
- U.S. and Canadian currencies are closely linked and generally shift from each other only slowly. As a result, B.C. would likely have cost advantages over Ak. in all major markets.

Study findings:

Many areas in Southcentral and Southeast are not suitable for fish farming due to large river systems, (i.e. the Stikine, Taku, Unuk, Chilkat, and Speel), ice, and icebergs.

Areas which would be favoured for development in terms of their proximity to population centers, airports and processing plants are:

- along the eastern half of S.E. Ak. near Taneau, Ketchikan and Petersburg/Wrangell;
 - along the western side of Baranof Isl. near Sitka;
 - in southcentral Ak. near Kodiak, Homer, Seward, Cordova, Valdez and Whittier. - The area around Ketchikan is probably the best area for development because of warmer summer and winter temps.
- *However, the Ketchikan area would have lower growth rates and higher conversion rates than in most areas of B.C. where salmon farming occurs because of seasonally lower water temps.

Smolt Production Capabilities

Four state hatcheries in S.E. produce chinook and three hatcheries produce coho salmon. (Chinook would likely be preferable for net pen rearing in Ak. since they have shown greater survival rates than coho during the longer growout periods in B.C.) In addition, 10 private non-profit hatcheries operated by aquaculture assoc. and other non-profit groups raise chinook or coho or are permitted to raise these species.

In '86, nearly 5 million chinook eggs were collected from these facilities and more than 2.7 million juvenile chinook were released. More than 4 million coho eggs were collected and 1.5 juvenile coho were released.

Five state hatcheries in southcentral produce chinook and five produce coho salmon.

In '86 1.5 million chinook eggs were collected and 1.5 million juvenile chinook were released. More than 6.5 million coho eggs were collected and 7 million coho juveniles were released.

Clearly, a large smolt production capability exists in both southcentral and S.E.

MEMORANDUM

State of Alaska

TO: Distribution

DATE: March 16, 1988

Sen Eliason

FILE NO:

TELEPHONE NO:

THRU:

SUBJECT: Cost of Production Model
for Pen Rearing and World
Markets for Salmon: Pen
Reared Salmon Impacts

FROM: Paul Peyton, Program Manager *Paul*
Division of Business Development
Department of Commerce & Economic
Development

Attached is the final report on Costs of Production. The World Market report is still being worked on due to difficulties in identifying existing domestic markets for Alaska's salmon. This information is not compiled anywhere and must be derived indirectly. The task has proved more difficult than anticipated and the completion date has been moved to March 23.

Please call if you have any questions or suggestions concerning these findings. I have asked the contractors to be available for hearings next week and they will be available the 22nd and later.

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COST OF PRODUCTION MODEL
FOR PEN-REARING OF SALMON IN ALASKA
AND CURRENTLY PRODUCING REGIONS

FINAL REPORT

Prepared for:
State of Alaska Department
Department of Commerce
and Economic Development
Juneau, Alaska

Prepared by:
The DPA Group Inc.
In association with
Hatfield Consultants Ltd.
and Dr. Trond Bjorndal
Vancouver, B.C.

March, 1988

EXECUTIVE SUMMARY

A. PURPOSE OF STUDY

The purpose of this study is to determine costs of production for net-pen rearing of salmon in Alaska. The State Department of Commerce and Economic Development commissioned the study in December, 1987 in conjunction with a second study to assess the impacts of projected farmed salmon supplies on markets for Alaska's wild salmon. Together, these studies can be used to determine the potential economic viability of production in Alaska.

The study first analyzes costs of production in the regions projected to be the largest suppliers. It then develops costs of production for Alaska from an analysis of biological, environmental and logistic conditions in the state.

B. SCOPE OF STUDY

Costs of production (COP) for Norway and Scotland were developed largely from recent studies. Costs of production for Chile were developed from recent studies and from COP models developed by Hatfield Consultants Ltd. for the Chilean industry. Costs of production for British Columbia were developed from a unit cost model recently developed by the DPA Group Inc. for the industry.

Costs of production for Japan were not developed because no cost of production data is available in the public domain or from the firsthand experience of study team members. However, sufficient data was obtained from previous studies and a recent visit by a study team member to draw some important conclusions about its cost structures and its development potential. These are presented in a narrative form.

In order to assess conditions for pen rearing salmon in Alaska we conducted reviews of previous environmental studies in Alaska. We also held telephone interviews with several fisheries officials in the state of Alaska Department of Fish and Game and the National Marine Fisheries Service.

In order to develop growth data and feed conversion ratios we compared published results of the National Marine Fisheries Service salmon farming research projects at Little Port Walter and Auke Bay to those of a recent broodstock management program in British Columbia.

C. COSTS OF PRODUCTION IN CURRENTLY PRODUCING REGIONS

A summary of unit costs for farmed salmon in each major supply region is shown in Exhibit 3.13. In all cases, product is assumed to be sold in a head-on, dressed form. In

the exhibit, a yield factor is applied to the unit costs previously calculated on a round weight basis. Yield factors range between 85% and 90%. Yields are highest with larger fish.

EXHIBIT A: COMPARATIVE DRESSED-WEIGHT UNIT COSTS IN US DOLLARS

	Norway	Scotland	B.C.	Chile	Japan
Unit Costs Per kg Round Wt. Basis	\$5.05	\$5.46	\$3.32	\$3.20	\$5.67
Average Size	4 kg	2.5 kg	3.4 kg	2.5 kg	2.0 kg
Processing Yield	.90	.87	.89	.87	.85
Unit Costs Per kg Dressed Wt. Basis	\$5.61	\$6.28	\$3.73	\$3.68	\$6.67
Unit Costs Per lb	\$2.55	\$2.85	\$1.70	\$1.67	\$3.03

Exchange rates to US dollars are 1987 year-end rates:

NOK: 6.2325; UK pound: 1.8715; CDN\$: 0.7693; Yen: 0.0081.

Source: As in Exhibit 3.12.

Chile and British Columbia have the lowest unit costs. Japan has the highest. However, the lower unit costs of the Chilean and British Columbian industries do not necessarily mean that higher returns are being earned in these regions. Freight costs to major markets are a significant factor. Pricing is based on numerous factors including size, species, and grade. Generally larger sizes and high quality are preferred attributes. Preferences for particular species will generally vary by area. Time of harvests and level of marketing effort will also influence net returns.

Large areas of southcentral and southeast Alaska are not suitable for salmon culture due to the presence of ice, icebergs and large river systems. Salinities are generally more consistent throughout the year in areas away from mainland waters, where blooms are also less likely to occur.

Smolt production capacity in both southcentral and southeast Alaska is likely adequate to meet potential demand from a salmon farming industry. Some fish feed production capability exists in southcentral, however fish feed would most likely be imported from Washington State or British Columbia because of more specialized production in these regions.

The following areas would be favoured for development in terms of their proximity to population centers, airports and processing plants:

- . along the eastern half of southeast Alaska near Juneau, Ketchikan and Petersburg/Wrangell;
- . along the western side of Baranof Island near Sitka;
- . in southcentral Alaska near Kodiak, Homer, Seward, Cordova, Valdez and Whittier.

Netpen operations in these areas would also be less likely to be affected by phytoplankton blooms. However, all areas are likely to be affected by predators.

D. COSTS OF PRODUCTION IN ALASKA

The area around Ketchikan is probably the best area for development of pen rearing of salmon in Alaska because of warmer summer and winter temperatures. This area also has more constant salinities throughout the year. Chinook could be expected to reach a harvestable size of two kilograms during the second winter in saltwater. However, the Ketchikan area would have lower growth rates and higher conversion rates than in most areas of British Columbia where salmon farming occurs because of seasonally lower water temperatures.

The cost profile of a farm assumed to be located in the Ketchikan area is summarized below.

Capital Investment

Capital investment is assumed to be similar to that of British Columbia. However, cage systems and equipment are assumed to be imported and slightly more expensive. The estimated total capital investment for the farm is shown below.

	U.S. \$
Sea cage system and equipment	\$380,000
Facility on floating barge with equipment	<u>250,000</u>
	\$630,000

The total capital investment is \$2,520 per tonne. Like British Columbia accommodation and other facilities are assumed to be on a floating barge due to the lack of extensive road systems in the south central portion of southeast Alaska.

Unit Costs

Unit costs are shown in Exhibit B. Unit costs are \$4.49 per kilogram.

EXHIBIT B: ESTIMATED UNIT COSTS PER KG FOR CHINOOK SALMON IN ALASKA

	Unit Costs (US Dollars)	%
Variable Costs		
Smolts	0.40	9
Feed	2.00	45
Stock Insurance	0.07	2
Processing	0.52	11
Interest on Working Capital	<u>0.27</u>	<u>6</u>
Total Variable Costs	3.26	73
Fixed Production Costs		
Wages	0.32	7
Overhead	0.24	5
Depreciation	0.49	11
Interest	<u>0.18</u>	<u>4</u>
Total Fixed Costs	1.23	27
Unit Costs per Kilogram	4.49	100%

Source: The DPA Group Inc.

Assuming a yield factor of about 85%, unit costs on a dressed weight basis would be \$5.28/kg or \$2.40/lb.

E. SUMMARY

The landed costs of farmed salmon from each major supply region and from Alaska in three major markets are shown in Exhibit C.

EXHIBIT C: COMPARISON OF LANDED COSTS PER LB IN MAJOR MARKETS
(U.S. DOLLARS)

Market	Supply Region					
	Norway	Scotland	B.C.	Chile	Japan	Alaska
Los Angeles	3.80	4.17	2.06	2.63	N/A	2.77
New York	3.46	3.83	2.44	2.63	N/A	3.18
Tokyo	4.25	4.62	2.89	3.85	3.21	3.36

As indicated in the exhibit, Alaska is competitive from a cost standpoint in all markets.

However, costs at an industry level are only well known for Norway. As a result, the cost comparison should be viewed with caution. Alaska would be selling farmed salmon in smaller sizes than Norway, Scotland and British Columbia and would compete more directly with Chile. British Columbia and Chile have cost advantages over Alaska in both Los Angeles and New York.

Alaska would also likely have a short window period in which to sell. This would also likely result in more direct competition with the Chileans.

Landed costs in major markets are sensitive to exchange rates. Fluctuating exchange rates could make Alaskan farmed salmon more or less competitive in all markets. However, the U.S. and Canadian currencies are closely linked and generally shift from each other only slowly. As a result, British Columbia would likely have cost advantages over Alaska in all major markets.

TABLE OF CONTENTS

	Page
1.0 PURPOSE AND SCOPE OF STUDY	1-1
2.0 OVERVIEW OF WORLDWIDE FARMED SALMON PRODUCTION	2-1
2.1 Introduction	2-1
3.0 COMPARATIVE COSTS OF PRODUCTION	3-1
3.1 Introduction	3-1
3.2 Norway	3-2
3.3 Scotland	3-8
3.4 British Columbia	3-12
3.4 Chile	3-16
3.6 Japan	3-19
3.7 Summary	3-21
4.0 COST OF PRODUCTION MODEL FOR ALASKA	4-1
4.1 Introduction	4-1
4.2 Environmental and Logistic Conditions	4-1
4.3 Growth and Conversion Rates	4-6
4.4 Estimated Costs of Production	4-9
5.0 SUMMARY	5-1

References

APPENDIX A:	Metric Conversion Rates
APPENDIX B:	Profitability Study of Fish Farms in Norway, 1984
APPENDIX C:	Potential Development Areas for Salmon Farming in Alaska: Technical Summary

1.0 PURPOSE AND SCOPE OF STUDY

Purpose of Study

The purpose of this study is to determine costs of production for net-pen rearing of salmon in Alaska. The State Department of Commerce and Economic Development commissioned the study in December, 1987 in conjunction with a second study to assess the impacts of projected farmed salmon supplies on markets for Alaska's wild salmon. Together, these studies can be used to determine the potential economic viability of production in Alaska.

The study first analyzes costs of production in the regions projected to be the largest suppliers. It then develops costs of production for Alaska from an analysis of biological, environmental and logistic conditions in the state.

Scope of Study

Costs of production (COP) for Norway and Scotland were developed largely from recent studies. Costs of production for Chile were developed from recent studies and from COP models developed by Hatfield Consultants Ltd. for the Chilean industry. Costs of production for British Columbia were developed from a unit cost model recently developed by the DPA Group Inc. for the industry.

Costs of production for Japan were not developed because no cost of production data is available in the public domain or from the firsthand experience of study team members. However, sufficient data was obtained from previous studies and a recent visit by a study team member to draw some important conclusions about its cost structures and its development potential. These are presented in a narrative form.

In order to assess conditions for pen rearing salmon in Alaska we conducted reviews of previous environmental studies in Alaska. We also held telephone interviews with several fisheries officials in the state of Alaska Department of Fish and Game and the National Marine Fisheries Service.

In order to develop growth data and feed conversion ratios we compared published results of the National Marine Fisheries Service salmon farming research projects at Little Port Walter and Auke Bay to those of a recent broodstock management program in British Columbia.

In the following section of the report we present an overview of worldwide farmed salmon production. In Section 3.0 we analyze and compare costs of production in each major supply region. In Section 4.0 we estimate costs of production in areas suitable for pen-rearing salmon in Alaska. In Section

5.0 we summarize Alaska's potential cost advantages and disadvantages.

2.0 OVERVIEW OF WORLDWIDE FARMED SALMON PRODUCTION

2.1 Introduction

Aquaculture is defined as the culturing of finfish, shellfish and aquatic plants. Species currently being cultured commercially include shrimp, oysters, carp, tilapia, catfish and salmon. Worldwide production from aquaculture has grown rapidly from about 2.6 million tonnes in 1970 to about 10 million tonnes in 1986, accounting for 10-12% of total fisheries output worldwide. China and Japan account for 35 percent of world aquaculture production. The United States produces two percent of the world total. Production is mostly catfish.

Aquaculture production can be classified as either extensive, semi-intensive or intensive. The extensive method is the simplest. Aquatic environments such as oceans and lakes are stocked at low densities with little management of the species and little or no supplemental feeding. The semi-intensive method involves higher stocking densities in smaller culture units, more intensive management and some supplemental feeding. The intensive method employs still higher stocking densities in a controlled environment.

Salmon ranching, roe on kelp and scallop spat collection in Alaska can be classified as extensive forms of aquaculture. Pond rearing of catfish and trout in several other states and seapen rearing of salmon in Washington and Maine are classified as semi-intensive production.

Intensive forms of aquaculture for the most part have only been successful with some tropical species although rearing of trout in Idaho could possibly be classified as such. Intensive rearing of Atlantic salmon in land-based tank farms has been attempted but has generally not been successful. Much greater success with rearing salmon has been achieved with netpen rearing of Atlantic salmon in Norway. Production has increased from 1,500 tonnes in 1975 to over 45,000 tonnes in 1986. Along with growing demand for fresh seafood in major markets, this industry has spurred the development of netpen rearing of salmon around the world.

The first phase of the production cycle is in a freshwater hatchery. Fertilized salmon eggs reach the smoltification stage anywhere between six and 18 months. Juveniles are then placed in netpens supported by floating cages situated in marine locations. The growout period in saltwater can take up to three years.

Supplemental feeding exists through most of the freshwater phase and virtually all of the saltwater phase. Pen-reared fish are typically fed commercially-produced pelleted feed.

World production of farmed salmon in 1986 is shown in Exhibit 2.1.

EXHIBIT 2.1: WORLDWIDE PRODUCTION OF FARMED SALMON IN 1986
(Metric Tonnes)

	Atlantic	Chinook	Coho	Total
Norway	45,675	-	-	45,675
Scotland	10,300	-	-	10,300
Ireland	650	-	-	650
Faroes	600	-	-	600
Iceland	100	-	-	100
Sweden	150	-	-	150
Finland	40	-	-	40
Spain	150	-	-	150
France	-	-	180	180
Italy	50	-	-	150
Eastern Canada	297	-	-	297
B.C.	-	89	400	489
Washington State	-	-	1,400	1,400
Chile	-	-	1,000	1,000
New Zealand	-	500	-	500
Japan	-	21	7,200	7,221
	58,012	610	10,180	68,802

Source: The DPA Group Inc. Worldwide Farmed Salmon
Production Forecasts to Year 2000, Department of
Fisheries and Oceans, 1988.

As indicated in the exhibit, Norway was the world's largest producer of farmed salmon in 1986, producing about two thirds of the world supply (or about 8% of the 1986 total supply of farmed and wild salmon). The other supply region with considerable Atlantic salmon production in 1986 was Scotland.

The culturing of Pacific species has been more recent and Japan was the only significant producer in 1986. In Washington State, pan-sized Coho production is well established but relatively static.

The production figures in 1986 significantly understate the production potential of British Columbia and Chile, where rapid expansions in the number and size of farms has occurred during the last three years. In British Columbia, emphasis has been with production of Chinook and Coho, with more limited production of trout and Atlantic salmon.

In a recent study conducted by the DPA Group Inc., we estimated that due to economic and biological factors, Norway, Scotland, B.C., Chile and Japan would emerge as the leading producers of farmed salmon, producing nearly 82% of the world's supply of farmed salmon by the year 2000.

A summary of actual farmed salmon production in 1986 and projections for 1990 and 2000 by major producing regions is shown in Exhibit 2.2.

EXHIBIT 2.2: PRODUCTION OF FARMED SALMON TO 2000
(tonnes)

	1990	(%)	1995	(%)	2000	(%)
Norway	100,000	63	150,000	56	200,000	51
Scotland	25,000	16	37,500	14	50,000	13
British Columbia	15,600	10	25,500	9	33,000	8
Chile	5,500	4	14,370	5	23,000	6
Japan	10,000	6	15,100	6	15,100	4
Other	2,260	1	27,590	10	72,860	18
Total	158,460	100	270,060	100	393,960	100

Source: The DPA Group Inc. Worldwide Farmed Salmon
Production Forecasts to the Year 2000, Department of
Fisheries and Oceans, 1988.

Norway and Scotland are projected to continue as world leaders in farmed salmon production to the end of the century because there is still significant opportunities for both industries to become more efficient and new cage technologies should allow them to continue with new site development in more exposed marine environments.

British Columbia and Chile have considerable areas with undeveloped coastlines and are generally believed to have better growing conditions than their European counterparts. To a large extent the salmon farming industries in these regions are less mature and opportunities to reduce costs are greater.

Japan on the other hand is affected by lethal water temperatures in summer which prevents long growout periods and requires harvesting within a short time period. Production is expected to continue to increase substantially however because farmed salmon can reach market size in less than one year.

The four largest supply regions are all expected to export most of their production. Japan is expected to consume all of its production to the end of the century. The major markets for farmed salmon are in the U.S., Japan and Europe. As indicated in Exhibit 2.2, the total production of farmed salmon in the year 2000 is projected to be about 0.4 million tonnes. The five major producing countries are expected to produce 0.32 million tonnes. Competition in these markets is therefore expected to increase, particularly in the U.S. where all of the major exporters currently compete.

In order to determine the viability of production in Alaska, the costs of producing pen-reared salmon in these supply regions should be compared to estimated costs of production in the state.

In the following section of the report we describe the costs of production in each major supply region.

3.0 COMPARATIVE COSTS OF PRODUCTION

3.1 Introduction

Costs of production of farmed salmon are largely determined from biological, environmental and technological factors. Industrial structure and political factors also influence costs. Industrial structure refers to the number and size of farms and their degree of vertical integration. Political factors include government support and restrictions.

However, there are several important factors to consider in the analysis. Firstly, the economics of salmon farming in most supply regions is not well understood. Industry-wide cost of production surveys in Norway, for example, have often overstated costs because many farms surveyed were in their development phases (Bjorndal, 1987). Surveys similar to those periodically undertaken in Norway have also yet to occur in British Columbia and Chile. Even if they had, the surveys would also likely not be very representative of the future cost structure of these industries since most farms established since 1984 first began production at small (pilot) scales and have yet to complete their second production cycle at larger scales.

Secondly, particularly with Pacific species, there is a considerable amount of experimentation being undertaken with genetic selection, sex manipulation, size and time of entry of smolts into saltwater, and stocking densities. The impacts of rapid improvements in broodstock and husbandry on costs of production are difficult to measure.

Empirical data from Norway suggests that there are modest economies of scale in production at the farm site level (Salvenes, 1986). However, the size of farms in Norway is restricted for the most part to small and medium-sized farms, yet in Scotland, B.C. and Chile horizontal integration, i.e. multi-site farms, is common. The level of vertical integration in these industries is also higher. Assessing how these structural differences and political constraints impact on costs of production are beyond the scope of this study. Structural aspects of each major supply region can however be described.

The approach adopted in the study is to develop unit costs for an efficient, industrial-scale growout site in each major supply region. This makes sense from several perspectives:

- . there is a general trend worldwide towards larger, industrial scale production units;
- . even though some industries have salmon farms with production capacities in excess of 1,000 tonnes annually, these tend to be spread over several

sites, in order to reduce risk; a typical site has a production capacity ranging between 100 and 400 tonnes;

- . it requires an assumption as to the location of the site which simplifies estimations of freight costs for inputs and shipments of production to market;
- * with increased competition for markets worldwide only the more efficient producers will likely survive.

Another factor to consider is how farms in each supply region are financed. The debt to equity ratio of farms in all regions is highly variable. To some extent they are dependent on the amount of government financial support available to farms in each region. However, as will be explained, government financial support in all regions is becoming less important. The rate of return therefore can be expected to equate to a firm's long run cost of capital. In the analysis a real rate of interest of 7% is assumed for all regions. Also land costs are disregarded.

A related factor is the tax structure to pay for the level of government support. However, only in Scotland is there a direct tax on production, although Norway may soon introduce an application fee for licences.

Also disregarded are general taxes. General tax rates vary considerably from region to region. In addition to income taxes, there are sales taxes, tax allowances and depreciation rates to consider. Comparative analyses of these by region would be very complex and are beyond the scope of the study.

Two final considerations are worthy of mention. While costs of production in various industries have been described in previous studies, they are not all in the same year and are not expressed in the same currencies. The approach taken is to first discuss costs of production in their local currencies. This should allow an easier comparison of costs in future years should exchange rates fluctuate. Costs of production from each major supply region are however translated to US dollars in the summary of this section.

The metric system is the recognized system of measurement in most countries. As a result, unit costs of production are first presented in this fashion and are also later converted to the U.S. system.

3.2 Norway

Structural Aspects

Norway is projected to continue as the world's largest producer of farmed salmon to the end of the century.

Production of Atlantic salmon in the year 2000 is forecasted to be 200,000 tonnes.

In 1985, there were about 559 growout farms with total growout capacity of about 3.4 million m^3 . Also there were about 150 new licences issued in 1985 (Bjorndal, 1987). By 1987, there were also 611 smolt producers with a total capacity of about 18 million smolts (Hempel, 1988).

The most important structural aspect is the presence of the large number of small farms because both pen volume and ownership of multiple site farms are restricted. These restrictions reflect the regional development policies of the Norwegian government. With the exception of some of the earliest farms, the size of farms is limited to a maximum of 8000 m^3 of netpen capacity.

The Norwegian government is considering a proposal from the Fish Farmers Association to allow a 50% increase in the maximum size of each farm, to 12,000 m^3 . Smolt production capacity is limited to one million smolts annually per unit although multiple unit ownership is permitted. Sea Farm A/S was the largest producer in 1985 and produced 9% of total output (Bjorndal, 1987).

The distribution of farms surveyed in the profitability survey in 1984 by size category is shown in Exhibit 3.2. Except for new entrants, the distribution is considered representative of the total population of farms. Most farms in the $>7000 m^3$ category are between 7000 m^3 and 8000 m^3 . A summary of the profitability study itself is shown in Appendix B.

EXHIBIT 3.2: DISTRIBUTION OF FARMS BY SIZE CATEGORY IN NORWAY IN 1984

	$<3000m^3$	3000- 4999 m^3	5000- 6999 m^3	$>7000m^3$	Total
No. of farms	19	31	20	27	97
Percent of Total	19%	32%	21%	28%	100%

Source: Profitability Study of Fish Farms, Directorate of Fisheries, 1984.

A regional breakdown of farms in 1985 is shown in Exhibit 3.3

EXHIBIT 3.3: DISTRIBUTION OF FARMS BY REGION IN NORWAY IN 1985

	Finnmark, Troms and Nordland	Nord- and Sor-Trondelag, More and Romsdal	Sogn og Fjordane, Hordaland	Rogaland, Skagerakkyst
No. of Farms	161	183	156	59
Percent of Total Production	22%	34%	38%	6%

Source: T.Bjorndal, Fiskeoppdretts - økonomi (Economics of Aquaculture)
Oslo: Cappelen, 1987.

The area with the largest amount of production includes the counties of Sogn og Fjordane and Hordaland which are located in the south. The city of Bergen is located in Hordaland. Profitability of farms in this area is also highest (see Appendix B).

The industry is supported by a strong marketing organization which negotiates with exporters minimum prices for producers and manages promotion campaigns for the industry. A levy of 1.25% of sales is assessed to both producers and purchasers/exporters to support these activities.

Government Support

Considerable government support has been provided to the industry since its inception. Financial assistance is provided mostly through the Regional Development Fund, in the form of loans, loan guarantees and grants to new business establishments in the regions. Financial support provided by the Regional Development during the period 1961-1986 totalled 1,279.3 million kroner as shown in Exhibit 3.4. However, in 1986, the Norwegian government made a decision to reduce financial support to farms. Further, it eliminated financial support programs for smolt producers.

**EXHIBIT 3.4: NORWEGIAN GOVERNMENT FINANCIAL SUPPORT TO
SALMON FARMING 1961-1986 (MILLION NOK)**

Year	Loans	Guarantees	Grant	Total
Total	388.0	678.9	212.4	1,279.3

Source: The Royal Norwegian Ministry of Fisheries

Significant public funds for scientific research and development are also allocated to the industry. Funding provided to government research institutions, universities, and research councils increased from 52.2 in 1984 to 152.1 million NOK in 1987 (Hempel, 1988).

The government does not provide any direct marketing support. However, two special marketing programs were recently introduced to increase exports of Norwegian seafood products to Japan and the U.S. No subsidies for export credit or transportation exists. However, between 1978 and 1980, Scandinavian Airline Systems (SAS), cooperated with major exporters in developing a transport and distribution system for fresh fish. During this period, SAS did offer preferential rates, but no longer does so. The government does not levy special taxes against the industry. However, it is considering charging an application fee for new licences.

Production Plan

Scale and Location

The analysis is undertaken for a fish farm raising Atlantic salmon in 8000 m³ of pen volume. The farm is assumed to be relatively efficient and can support stocking densities as high as 25 kg/m³ and therefore produce about 200 tonnes annually.

The farm is assumed to be located in an area between Bergen and Trondheim with nearby access to road connections.

Capital Investment

The total capital investment for the farmer is shown below.

	NOK (000's)
Sea cage system with equipment	1,835
Facility on land with equipment	<u>1,765</u>
	3,600

Source: Bjorndal, 1987.

The total capital investment is 3.6 million NOK or 1,800 NOK per tonne.

Operating Expenses

The estimated operating costs are based on the following assumptions:

- 60,000 salmon smolts are set out every year in May;
- The smolt price is 14 kr;
- The feed price is 6 kr per kilogram;
- The feed conversion ratio is 1.7:1;
- Mortalities are:
 - . 7% in the first month after release
 - . 4% during the next four months
 - . 2% per half year for the balance of the production cycle;
- Processing costs are 5 kr per kilogram;
- Stock insurance is 3% of the average carrying value of inventory;
- Labour: 4 person years;
- Wages including benefits are:
 - . 250,000 kr for a farm manager
 - . 200,000 kr for three farm labourers;

- Overhead costs include insurance on fixed assets, electricity, fuel, repair and maintenance, medicine, and administration;
- Harvesting begins about 20 months after the release of smolts and continues at the same rate over the year;
- Average weight of fish is 4 kg at harvest.

With these assumptions this farm will be capable of producing about 50,000 fish for a total production of 200 tonnes per year after the third year from startup.

Fixed assets are depreciated on a straight line basis over the following periods:

	Years
Buildings	20
Seapen system and equipment	6
Site investments	50

The investment in buildings includes a processing facility. The seapen system is depreciated over a 6-year life. However the economic life of newer steel cage systems used in Norway is not yet well known. Technological obsolescence may also become a factor beyond a certain period.

Unit Costs

Unit costs are shown in Exhibit 3.5. They are derived from 1986 cost data. Unit costs per kilogram are 31.45 kroner (14.30 kr/lb).

**EXHIBIT 3.5: UNIT COSTS PER KG FOR ATLANTIC SALMON
PRODUCTION IN NORWAY**

	Unit Costs (kr)	%
Variable Costs		
Smolts	4.20	13
Feed	10.70	35
Stock Insurance	0.85	3
Processing	4.40	14
Interest on working capital	<u>2.00</u>	<u>6</u>
Total Variable Costs	22.20	71
Fixed¹ Costs		
Wages	4.25	14
Overhead	2.00	6
Depreciation	1.70	5
Interest on capital	<u>1.30</u>	<u>4</u>
Total Fixed Costs	9.25	29
Unit costs per kilogram	31.45	100

Source: Bjorndal, 1987.

¹ includes some semi-variable costs such as wages.

3.3 Scotland

Structural Aspects

Scotland is projected to produce 50,000 tonnes of farmed salmon in the year 2000 and remain the world's second largest producer of farmed salmon to the end of the century. Like Norway, Scotland will continue to produce Atlantic salmon.

No restrictions on size or ownership exist in Scotland. In 1987, 126 companies operated 196 cage sites and 11 tank sites. There were also 72 smolt production companies who operated 80 tank and 51 cage sites.

Groupings of sea farm sites by their scale of production in 1987 is shown in Exhibit 3.6. As indicated in the exhibit, the largest concentration of farms are in the 101-200 to 201-300 tonne range.

In contrast to Norway, there is more concentration of production and more vertical integration. In 1987, 45% of production was from the largest 20 farms.

EXHIBIT 3.6: DISTRIBUTION OF SEA FARM SITES IN SCOTLAND BY SCALE OF PRODUCTION IN 1987

Production (tonnes)	Number of Sites	% Share of Production
0	49	0
<10	21	0.9
10-25	41	5.5
26-50	15	4.4
51-100	24	13.9
101-200	26	30.5
201-300	13	24.2
300-400	5	12.9
400-500	1	3.4
>500	1	4.3
Total Sites	196	100

Source: Department of Agriculture and Fisheries for Scotland.

Salmon and smolt production in various regions of Scotland are shown in Exhibit 3.7.

EXHIBIT 3.7: SALMON AND SMOLT PRODUCTION IN VARIOUS REGIONS OF SCOTLAND

	Western Isles	Northern Isles	Rest of Scotland	Totals
1987 salmon (tonnes)	1,830	2,211	8,680	12,721
1987 smolts (numbers '000)	2,059	112.8	11,122.6	13,294.4

Source: Department of Agriculture and Fisheries for Scotland.

Most production is off the mainland of Scotland, particularly on its western shores.

The Scottish Salmon Growers Association provides marketing support to the industry through advertising campaigns. The Association charges a levy on smolts in inventory to pay for the costs of promotion.

Government Support

The Highlands and Islands Development Board has been central in channelling UK government financial support to the industry. Most farms are sited within the area covered by its jurisdiction. Between 1965 and the end of 1987 the Board itself had provided a total of 50.7 million pounds in financing to the industry. Most of this was in the form of grants which after a qualifying period, are non-repayable, but part constituted loans and equity participation. During the same period, about 4.1 million pounds have gone to scientific research and development. Two EEC programs, FEOGA and IDP, have also provided funding to the industry. However, like HIDB, funds have not increased with the growth in the industry.

A royalty is now being collected by the government on output. A royalty of 50 pounds per metric tonne applies to farms with production in excess of 50 tonnes. For those with less than 50 metric tonnes of production, a royalty of 45 pounds per metric tonne applies. Royalties in 1987 could have represented as much as 15% of the research and development funds provided to the industry through HIDB.

Production Plan

Scale and Location

The analysis is undertaken for a fish farm raising Atlantic salmon at annual production levels of 200 tonnes.

The farm is assumed to be located on the Scotland's west coast.

Capital Investment

The total capital investment for the farms is shown below.

	Pounds Sterling (000's)
Sea cage system and equipment	220.0
Facility on land with equipment	<u>146.3</u>
	366.3
Source: Shaw and Muir, 1987.	

The capital investment is 0.366 million pounds or 1,831.5 pounds per tonne.

Operating Expenses

The estimated operating costs are based on similar assumptions to those of Norway except for the following:

- smolt prices are slightly lower at 1.25 pounds
- smolt to harvest survival rate is 80%
- wages are also lower:

Farm Manager 25,000 pounds

Labour 7,500 pounds

The average size of fish at harvest is also lower at 2.5 kg. As a result, about 100,000 smolts are initially required to reach production of 200 tonnes.

Unit Costs

Unit costs are shown in Exhibit 3.8. They are derived from 1986 cost data. Unit costs per kilogram are 2.92 pounds (1.33 pounds/lb).

**EXHIBIT 3.8: UNIT COSTS PER KG FOR ATLANTIC SALMON
 PRODUCTION IN SCOTLAND**

	Unit Costs (Pounds)	%
Variable Costs		
Smolts	0.65	22
Feed	1.00	34
Stock Insurance	0.10	3
Processing and Packaging	0.20	7
Interest on working capital	<u>0.12</u>	<u>4</u>
Total Variable Costs	2.07	72
Fixed Costs		
Wages	0.28	9
Overhead	0.27	9
Depreciation	0.17	6
Interest on capital	<u>0.13</u>	<u>4</u>
Total Fixed Costs	0.85	28
Unit Costs per Kilogram	2.92	100%

Source: S.A. Shaw and J.F. Muir, Salmon: Economics and Marketing, Croom Helm, 1987.

3.4 British Columbia

Structural Aspects

British Columbia is projected to be the world's third largest producer of farmed salmon by the end of the century. Production is forecast to be 33,000 tonnes in 2000, 75% of which is projected to be comprised of chinook salmon.

No restrictions on size or ownership exist in British Columbia. In 1987, 85 farms operated 115 sites. Smolt production is concentrated to a few producers. Eight smolt producers produced about 90% of production in 1987. Total production capacity was about 30 million smolts. (B.C. Salmon Farmers Association).

No breakdown by production size or geographic area was available for 1987. However, DPA conducted a study in 1986 which projected the number and size of farms for 1987 through to 1990 (the projected number of farms for 1987 was 82 farms operating 113 sites). The study projected a trend towards increased concentration of production: 60% of the production in 1990 would be from 12% of the farms. The area projected to have the largest amount of production through to 1990 was the Sunshine Coast.

The study also projected a trend towards more vertical integration, including backward integration by fish processing companies through the provision of working capital financing to farms.

Technologies employed are similar to those of Norway and Scotland. However, stocking densities, particularly with chinook, are much lower than in the Norwegian or Scottish industries. Stocking densities are generally less than 8 kg/m³, significantly lower than in Norway.

The B.C. Salmon Farmers Association (BCSFA) provides marketing support to the industry. The BCSFA began a generic promotion campaign in 1987. A levy was previously charged on wild salmon eggs distributed to producers. In 1988, the levy is being shifted to smolt sales, since increasingly the industry is becoming self sufficient in egg supplies.

Government Support

Direct financial assistance to the industry has been mostly loans provided by a joint federal/provincial program for industrial development and an agricultural credit program of the provincial Ministry of Agriculture and Fisheries. The total outstanding loans at the end of 1987 from these programs were \$3.8 million (57 loans) and \$0.3 million (11 loans) respectively. The joint federal/provincial program expires in 1988.

Aquaculture is also a qualifying industry for a provincial venture capital corporation (VCC) program in which investors can qualify for a credit of up to 30% of their investment. A total of five aquaculture VCC's have been formed.

Support for scientific research and development is also being provided by the provincial Ministry of Agriculture and Fisheries and the federal Department of Fisheries and Oceans. Total support in 1987 was about \$3 million.

There are no special taxes or royalties levied against the industry. Annual lease costs for aquatic land are usually less than \$2,000.

Production Plan

Scale and Location

The analysis is undertaken for a fish farm raising chinook salmon at an annual production level of 250 tonnes.

The farm is assumed to be located in the Sunshine Coast area.

Capital Investment

The total capital investment for the farm is shown below.

	\$Cdn (000s)
Sea cage system and equipment	442
Facility on floating barge with equipment	<u>308</u>
	750

Accommodation and storage facilities are assumed to be on a floating barge. The total capital investment is \$3,000 per tonne.

Operating Expenses

The estimated operating costs are based on the following assumptions:

- 104,000 salmon smolts are set out every year in June;
- the smolt price is \$.75 which includes a BCSFA levy of \$.08;
- the feed price is \$1.00 per kg;
- the feed conversion ratio ranges between 1.3 and 1.9;

- Mortalities range between 1% and 3% per month;
- Processing costs are \$0.77 per kg;
- Stock insurance is calculated as 4% of the average carrying value of inventory;
- Labour - 4 person years;
- Wages including benefits are:

General Manager	\$35,000
Farm Manager	25,000
Labourer 1	17,500
Labourer 2	<u>17,500</u>
	\$95,000

- Fixed costs include insurance on buildings and equipment, electricity, fuel, repair and maintenance, medicine and administration;
- Harvesting occurs between 16 and 24 months in saltwater;
- Average weight of fish is 3.4 kg at harvest.

With these assumptions the farm will be capable of producing about 73,500 fish for a total production of 250 tonnes per year. The harvest weight of 3.4 kg reflects the current production strategies of most farms. However, the average size of chinook harvested to date has been less than 3 kg (B.C. Salmon Farmers Association).

Fixed assets are depreciated on a straight line basis over the following periods:

	Years
Buildings	20
Seapen system and miscellaneous equipment	6
Site investments	50

The economic life of fixed assets in British Columbia is assumed to be the same as Norway's and Scotland's because similar technologies are employed in each industry.

Unit Costs

Unit costs are shown in Exhibit 3.9. They are derived from 1987 cost data. Unit costs are \$4.32 per kilogram (\$1.96/lb).

**EXHIBIT 3.9: UNIT COSTS PER KG FOR CHINOOK SALMON IN
 BRITISH COLUMBIA**

	Unit Costs \$Cdn	%
Variable Costs		
Smolts	0.26	6
Feed	1.47	34
Stock insurance	0.09	2
Processing and packaging	0.77	18
Interest on working capital	<u>0.29</u>	<u>7</u>
Total Variable Costs	2.88	67%
Fixed Costs		
Wages	0.38	9
Overhead	0.30	7
Depreciation	0.56	13
Interest on capital	<u>0.20</u>	<u>5</u>
Total Fixed Costs	1.44	33%
Unit Costs per Kilogram	4.32	100%

Source: The DPA Group Inc., 1988

3.5 Chile

Structural Aspects

Chile is projected to be the world's fourth largest producer of farmed salmon by the end of the century. Production by the year 2000 is forecast to be 23,000 tonnes, about 60% of which is expected to be coho salmon. The balance is expected to be mostly Atlantic salmon, with only limited production of chinook salmon. Chinook production is mostly limited by shortages of eggs available for import.

In 1986, 22 farms producing salmon and/or trout were in operation.

No restrictions on size or ownership exists. Groupings of farms by their installed capacity in 1986 is shown in Exhibit 3.10. The data includes an unspecified amount of trout production capacity.

EXHIBIT 3.10: DISTRIBUTION OF FARMS IN CHILE BY SCALE OF OPERATION IN 1986

Production Range	No. of Farms	Total
1-10	3	14
11-100	3	14
101-300	6	27
301-500	6	27
501-1000	2	9
>1000	<u>2</u>	<u>9</u>
	22	100%

Source: Ricardo Mendez Zamorano Desorrollo Y Estado De Situacion Actual De La Salmoniculture En Chile, Fundacion Chile, 1987.

Salmon production in Chile is concentrated in an area south of Puerto Montt.

The industry is characterised by sizeable companies rather than small family operations. A number of the companies also own seafood processing plants in southern Chile.

Growing conditions in Chile are generally considered to be slightly better than British Columbia. To date the industry has been mostly reliant on imports of coho salmon from the states of Washington and Oregon. Typically, juveniles are placed in saltwater after 10 months in freshwater which is

usually in December when they have reached 35 grams. The reliance on wild coho eggs has meant that production has been mostly harvested after 12 to 16 months in saltwater in sizes ranging from 1.5 to 2.5 kilos. If fish are not harvested in this time period, early maturation usually occurs and they cannot be held over until the following fall and winter.

Government Support

No direct financial assistance is provided to the industry. There are also no export credits or transportation subsidies. Some support for research and development is provided through Fundacion Chile, CORFO and some state universities. Some marketing support is also provided through PROCHILE (Mendez (1988)).

Production Plan

Scale and Location

The analysis is undertaken for a fish farm raising coho salmon at annual production levels of 200 tonnes.

The farm is assumed to be located in an area south of Puerto Montt.

Capital Investment

The total capital investment for the farm is shown below (prices in Chile are usually quoted in U.S dollars):

Sea cage system and equipment	\$124,000
Facility on land with equipment	<u>83,000</u>
Total	\$207,000

Source: Mendez, 1987.

The total capital investment is about \$1,000 per tonne.

Operating Expenses

The estimated operating costs are based on the following assumptions:

- 93,000 salmon smolts are set out every year in December;
- the smolt price is \$0.40;
- the smolt size is 35 grams;

- the feed price is \$0.65 per kg;
- the average feed conversion ratio is 2:1;
- Mortalities are:
 - . 7.5% in the first quarter;
 - . 4.5% in the second
 - . 1.5% in subsequent
- Labour:

. Farm General Manager	14,400
. Operations Manager	12,000
. Technical Support (2 Advisors)	24,000
. Labourers (17)	<u>20,400</u>
	70,800
- Fixed costs include annual lease costs, insurance, electricity, fuel, repair and maintenance, medicine, and administration;
- Harvesting begins in mid December, 12 months after the release of smolts and continues until the end of March;
- Average weight of fish is 2.5 kg at harvest.

With these assumptions the farm will be capable of producing about 80,000 fish for a total production of 200 tonnes per year.

Fixed assets are depreciated on a straight-line basis over the following periods:

	Years
Building	10
Seapen system and miscellaneous equipment	3
Site investments	25

Fixed assets are depreciated over fewer years than in Europe or British Columbia because lower quality designs, i.e. wooden cages, are typically used.

Unit Costs

Unit costs are shown in Exhibit 3.11. They are derived from 1987 cost data. Total unit costs are \$3.20 per kilogram (\$1.45/lb).

EXHIBIT 3.11: UNIT COSTS PER KG FOR COHO SALMON PRODUCTION
IN CHILE

	Unit Costs USD	%
Variable Costs		
Smolts	0.19	6
Feed	1.21	38
Stock insurance	0.10	3
Processing	0.50	16
Interest on working capital	<u>0.18</u>	<u>6</u>
Total Variable Costs	2.18	69
Fixed Production Costs		
Wages	0.60	18
Overhead	0.26	8
Depreciation	0.09	3
Interest on capital	<u>0.07</u>	<u>2</u>
Total Fixed Costs	1.02	31
Unit Costs per Kilogram	3.20	100%

Sources: Hatfield Cons. (1987), Mendez (1987),
Wurmann (1987)

3.6 Japan

Japan is projected to be the world's fifth largest producer of farmed salmon by the end of the century. Production by the year 2000 is projected to be 15,000 tonnes and almost entirely comprised of coho salmon. Virtually all production in 1986 was coho salmon. About 20-25 tonnes of chinook was reportedly produced. Experimentation with Atlantic salmon rearing is also being undertaken.

Production is largely at small scales and organized through cooperatives. In 1986, a total of 19 organizations operated 264 sites. Average production per site in 1986 was 28 tonnes, indicating small scale production. Bjorndal confirmed this in a visit in 1987. Further he indicate low level technologies for cage design and feeding systems are employed.

Eighty seven percent of the sites were located around Miyagi, near the northeast end of Honshu. In 1986 these sites produced 81% of the total production.

Although the scale of growout sites is very small compared to other industries, processing and marketing is concentrated to three large processing companies, most notably Nichero Fisheries.

Since the industry began in 1973, it has relied on imports of coho salmon eggs from Washington and Oregon.

Feed production is also not undertaken at a large scale. Supplies of mackerel, sardine and mysid shrimps are available year around for feed production from local parts.

Government Support

No direct financial assistance has been provided to the industry.

Production Plan

Coho smolts are usually one year olds (SI's) when they are placed in saltwater at average sizes of 150 grams from mid-October to early November. The fish are then raised in net pens for about 7-9 months at stocking densities of 10 to 15 kg/m³.

The coho can grow to 2.5 kilograms by July and are harvested between 1.5 kg and 2.5 kg. Coho must be harvested before August because lethal temperatures are reached.

Unit Costs

Unit cost data for Japan is not available in the public domain. However, the production cost of farmed salmon in 1986 was reportedly about 700 yen/kilo (318 yen/lb) (Sato, 1987). Prices for eggs were six yen per egg. Prices for smolts weighing between 100 grams and 250 grams were 1,000-1,500 yen per tonne. Feed consists of moist pellets manufactured from mostly raw fish (sardine, mackerel and filefish) with some formulated feed added.

3.7 Summary

A summary of capital investment per tonne is shown in Exhibit 3.12.

EXHIBIT 3.12: COMPARATIVE CAPITAL INVESTMENT PER TONNE IN U.S. DOLLARS

	Norway	Scotland	B.C.	Chile	Japan
Capital Investment per tonne (local currency)	18,000	1,832	3,000	238,140	N/A
Capital Investment per tonne					
1987	2,888	3,428	2,308	860	-
1986	2,432	2,701	2,173	1,000	-

Conversion to U.S. dollars are at 1987 (1986) year-end rates:¹

NOK: 6.2325 (7.400); U.K. pound: 0.5343 (0.6782);
Cdn \$ 1.2998 (1.3805); Peso: 238.14 (204.73).

¹ International Financial Statistics, Vol. XLI No. 1, January, 1988. International Monetary Fund, Washington, D.C.

Scotland has the highest capital investment per tonne. The significant difference in capital costs between Scotland and Norway in 1987 is largely due to exchange rate fluctuations. However, sites are generally more costly to develop in Scotland because they are located in areas more remote from population centres. Also, sites with greater exposure are more common in Scotland. In addition, cage systems tend to be imported from Norway. British Columbia has lower investment costs than Norway because facilities are assumed to be on floating barges and they do not conclude processing facilities.

The economic life of fixed assets in the regions is assumed to be the same since similar technologies in cage design are employed in each area. Chile has the lowest capital investment cost per tonne because of the use of lower quality cage systems and lower building costs. However the economic life of fixed assets is assumed to be half that of other regions. The capital investment per tonne in Japan is not known but is assumed to be similar to Chile's.

A summary of unit costs for farmed salmon in each major supply region is shown in Exhibit 3.13. In all cases, product is assumed to be sold in a head-on, dressed form. In the exhibit, a yield factor is applied to the unit costs previously calculated on a round weight basis. Yield factors range between 85% and 90%. Yields are highest with larger fish.

EXHIBIT 3.13: COMPARATIVE DRESSED-WEIGHT UNIT COSTS IN US DOLLARS

	Norway	Scotland	B.C.	Chile	Japan
Unit Costs Per kg Round Wt. Basis	\$5.05	\$5.46		\$3.20	\$5.67
Average Size	4 kg	2.5 kg		2.5 kg	2.0 kg
Processing Yield	.90	.87		.87	.85
Unit Costs Per kg Dressed Wt. Basis	\$5.61	\$6.28	\$3.73	\$3.68	\$6.67
Unit Costs Per lb	\$2.55	\$2.85	\$1.70	\$1.67	\$3.03

Exchange rates to US dollars are 1987 year-end rates:

NOK: 6.2325; UK pound: 1.8715; CDN\$: 0.7693; Yen: 0.0081.

Source: As in Exhibit 3.12.

Unit costs in local currencies are not all expressed for the same years. As previously indicated they are not converted to US dollars in the year collected because the impact of fluctuations in exchanges rates would then be difficult to gauge. In addition a domestic inflation factor for each country since the year the data is collected is also not applied because for the most part input costs do not correlate directly with general price indices. For example, the cost of feed is largely dependent on the world price of fish meal and fish oil which can fluctuate significantly due to biological factors such as El Nino's in South America.

As indicated in the exhibit, Chile and British Columbia have the lowest unit costs. Japan has the highest. However, the lower unit costs of the Chilean and British Columbian industries do not necessarily mean that higher returns are being earned in these regions. Freight costs to major markets are a significant factor (these are discussed in Section 5.0). Pricing is based on numerous factors including size, species, and grade. Generally larger sizes and high

quality are preferred attributes. Preferences for particular species will generally vary by area. Time of harvests and level of marketing effort will also influence net returns.

Exchange rates can affect costs significantly, particularly since the largest producers (except Japan) export most of their production. Exhibit 3.14 compares the same unit costs translated at average rates in 1986.

EXHIBIT 3.14: IMPACT OF EXCHANGE RATES ON UNIT COSTS PER LB

	Norway	Scotland	B.C.	Chile	Japan
Unit Costs/lb 1987	2.55	2.85	1.70	1.67	3.03
Unit Costs/lb 1986	2.18	2.25	1.60	1.44	2.35
% Change	7%	27%	6%	6%	29%

Exchange rates to U.S. dollars are at 1987 (1986) year-end rates:
 NOK: 6.2325 (7.400); U.K. pound: 0.5343 (0.6782);
 Cdn \$ 1.2998 (1.3805); Peso: 238.14 (204.73); Yen: 0.0081 (0.0063)

Source: As in Exhibit 3.12

The exhibit indicates that all unit costs expressed in US dollars were lower in 1986. The impact was most dramatic with the change in value of the pound sterling. The analysis partially explains some trends in the industry, including less than anticipated sales by Norway in the US in 1987. Norway did however place more emphasis on penetrating the Japanese market. In 1987 Chile also began selling to Japan.

4.0 COST OF PRODUCTION MODEL FOR ALASKA

4.1 Introduction

Development of likely costs of production in Alaska requires an analysis of conditions for rearing. British Columbia is considered the best model for analysis of Alaska's potential for three important reasons:

- . British Columbia more closely parallels Alaska socio-economically and environmentally than other regions;
- . the predominant species reared in British Columbia are Pacific species and these would also be the predominant species reared in Alaska because of restrictions on imports of exotic species into the state;
- . British Columbia and Alaska would likely serve similar markets.

In this section we summarize the following analysis described in a technical appendix prepared by Hatfield Consultants Ltd.:

- . general environmental and logistic conditions for pen-rearing salmon in Alaska;
- . differences in growth and feed conversion rates between British Columbia and Alaska.

We then develop likely unit costs of production for Alaska from these for the area with the best development potential.

4.2 Environmental and Logistic Conditions

Conditions which are important in considering the location of a netpen site can be classified under environmental or logistic categories.

Environmental factors include water quality characteristics and potential problems with plankton blooms and predators. Logistic factors include access to critical inputs such as smolts, feed, labour and transportation routes.

These conditions are discussed for southcentral and southeast Alaska, the two areas which according to state fisheries officials contacted, development of net-pen rearing of salmon would most likely occur.

4.2.1 Physical Marine Conditions

An overview of ice formation and iceberg conditions, temperatures and salinities in southcentral and southeast Alaska is presented. The information is then used to develop assumptions about growing conditions, growth rates and feed conversions.

Southcentral Alaska

Ice Formations and Icebergs

Ice formation and the presence of icebergs in embayments and low winter air temperatures impose constraints on development of netpen sites in southcentral Alaska; in particular, these are:

- . the presence of pack ice and fast ice in Cook Inlet;
- . the presence of ice and icebergs in embayments connected to Prince William Sound and near Seward; and
- . the potential for ice formation on floating structures.

Apart from the presence of sea ice and glacier ice in embayments in southcentral Alaska, the air temperature and wind conditions in that area make it generally susceptible for ice formation on floating structures (La Belle *et. al.* 1983).

Water Temperatures

Studies have shown that growth of salmon fed normal rations is highest at approximately 15°C (Brett, 1982). Below 5°C, conversion drops off appreciably. Mean winter surface temperatures in South Central can be expected to be between 2.5 and 5.0°C and mean summer surface temperatures can be expected to range between 7°C and 13°C.

Salinity

Lower and fluctuating salinities can affect the physiological condition of the salmon (i.e. in relation to the osmoregulatory adaptation to ambient salinity levels) and can influence outbreaks of harmful phytoplankton. In other words sudden variation in salinity levels can cause stress in fish. Generally growth is best under conditions of moderate salinity.

Xiong and Royer (1984) state that average surface salinities in summer are 27.3‰ and in winter are 31.2‰, based on intensive studies near Seward. At greater depths (i.e. 250 m), salinities are approximately 33‰ year round. Colonell (1980) and Muench and Nebert (1973) describe the presence of relatively fresh water lying in a thin surface layer in Valdez Arm and Port Valdez during summer and autumn. Muench and Nebert (1973) indicate that minimum mean surface

October period, though salinities in the upper 20 m were, at times, less than 1‰ near the head of Port Valdez (in late July/early August). Lower surface salinities over the summer period are attributed to freshwater runoff from land areas and high precipitation.

Southeast Alaska

Icebergs

Icebergs are present in several bays and straits in northern and eastern Southeastern Alaska (LaBelle et al, 1983):

- . Cross Sound, Icy Strait and Glacier Bay;
- . Taku Inlet;
- . Tracy Arm and Endicott Arms; and
- . the end of Frederick Sound.

The presence of icebergs suggests a potential for damage to floating structures and, in general, these areas would be avoided. Also, the icebergs apparently can greatly reduce summer temperatures in surface waters (Pickard, 1967).

Water Temperatures

Mean monthly surface temperatures for the coastal waters along southeast Alaska (Brower et al, 1977) and five lighthouse installations (Jones, 1978) in southeast Alaska and in Auke Bay near Juneau (Bruce et al, 1977) were analyzed.

These data show mean high temperatures in summer to range between 9.0°C and 14.6°C. Mean low temperatures in winter range between 2.3°C and 5.2°C. The mean low temperature for the general coastal area (Brown et al, 1977) is slightly higher than these values at 6.0°C.

Salinities

Larger rivers along the mainland shoreline can produce lower and fluctuating salinities (Pickard, 1967) and consequently make nearby areas unsuitable for locating netpens for adult growout. These areas include the mouths of the Stikine River, Taku River, Unuk River, Chilkat River and Speel River.

4.2.2 Phytoplankton and Marine Mammals

Phytoplankton

Two phytoplankton species, Chaetoceros convolutus and Heterosigma akashiwo, have caused serious mortalities amongst salmon cultured in marine netpens in British Columbia. Chaetoceros convolutus causes asphyxiation through physical damage of the gills by silicate processes projecting from the diatom. Heterosigma akashiwo can also lead to asphyxiation because they are toxic to salmon and cause irritation and

mucus buildup in gills. Conditions appear suitable for both species in southcentral and southeast Alaska (Gaines and Taylor, 1986). Chaetoceros diatoms have been responsible for chinook salmon mortalities in seapens at Little Port Walter (National Marine Fisheries Service, unpublished). Chaetoceros convolutus has also been collected during surveys near Valdez in Prince William Sound (Horner et al 1973.) The occurrence and intensity of phytoplankton blooms vary greatly both geographically and temporally and prediction is difficult (Gaines and Taylor, 1987). In general, *Heterosigma* blooms tend to occur in early summer, often in association with lower salinities resulting from increasing river flow, while *Chaetoceros* blooms tend to occur in the late summer or fall.

Harmful phytoplankton could affect sites in both southcentral and southeast Alaska. As in British Columbia, the effects on production could be direct mortalities or reduced growth when oxygen depletion occurs and rations are restricted.

Marine Mammals

Marine mammals such as otters and sea lions have affected production at sites in British Columbia by killing fish in pens, by damaging netpens allowing fish to escape, and by causing high stress levels in the fish thereby reducing growth rates. A National Marine Fisheries Service report (unpublished) indicates that otters, seals and possibly sea lions have killed fish at the experimental facilities near Little Port Walter. Steller's sea lions and harbour seals occur essentially along the entire Gulf of Alaska coastline (U.S. Department of the Interior, 1984).

Predation from marine mammals will likely be a similar problem in southcentral and southeast Alaska waters to that which occurs in British Columbia. This will require investment in predator control measures such as predator nets. Again, density levels would likely be kept low so that if stress develops when predators are nearby (but do not necessarily attack fish in the pens), it would not compound stress already resulting from high densities.

4.2.3 Smolt Production Capabilities

Southeast Alaska

Four state hatcheries in southeast Alaska produce chinook salmon and three hatcheries produce coho salmon (Hansen, 1987). In addition, 10 private non-profit hatcheries operated by regional aquaculture associations and other non-profit groups raise chinook or coho or are permitted to raise these species.

In 1986, nearly 5 million chinook eggs were collected from these facilities and more than 2.7 million juvenile chinook

were released. Similarly, slightly more than 4 million coho eggs were collected and 1.5 juvenile coho were released.

In 1986, private non-profit hatcheries in southeast Alaska had total permitted chinook egg capacities of 6.73 million and total permitted coho egg capacities of 15.47 million eggs. Most fry production of both species is in the Whitman Lake and Neets Bay hatcheries operated by the Southern Southeast Regional Aquaculture Association.

Southcentral Alaska

Five state hatcheries in southcentral Alaska produce chinook salmon and five hatcheries produce coho salmon. In 1986, 1.5 million chinook eggs were collected and 1.5 million juvenile chinook were released. Slightly more than 6.5 million coho eggs were collected and 7 million coho juveniles were released.

Three private non-profit hatcheries operated by regional aquaculture associations and other non-profit groups raise chinook or coho salmon or are permitted to raise these species. In 1986, the private non-profit hatcheries had total permitted chinook egg capacities of 1.15 million and total permitted coho egg capacities of 3.1 million.

Clearly, a large smolt production capability exists in both southcentral and southeast Alaska and this production is spread throughout each region. Hansen (1987) indicates that a number of hatcheries are constructed below lakes and water intakes in the lakes are placed at different depths so temperatures can be adjusted. This means juvenile growth rates and smolt timing can be manipulated to achieve release objectives.

4.2.4. Fish Feed

Currently there is fish feed production capacity in southcentral. However, capacity is limited and technologies employed in production are not as advanced as those in Europe, British Columbia or Washington State.

The main ingredients in commercial fish feeds are fish meal and fish oil. These are manufactured in the reduction process from whole fish or fish waste from the processing sector. Alaska's reduction industry is not well developed, despite the availability of significant quantities of fish waste. In addition the reduction plants in Alaska produce fish meal and fish oil which is unsuitable for fish feed. According to representatives of a fish feed manufacturer in Washington State, if a new feed plant were to be constructed, it would likely be constructed in tandem with a new reduction plant, both of which would require significant capital investment. Alaska would more likely be supplied by fish feed manufacturers in Washington State or British Columbia since transport by barge to Alaska is not a significant cost.

4.2.5 Potential Development Areas

Initial development could be expected to occur in suitable bays or shoreline areas (protected from high winds or waves) away from areas affected by water ice cover, icebergs and large river systems and as close to transportation centers and processing/packing facilities as possible.

Small to medium-sized communities having airport and port facilities are distributed throughout both southcentral and southeast Alaska. Apart from the major airport in Anchorage, smaller airfields and port facilities are located throughout the area (e.g., Homer and Seward).

Larger airports and port facilities are situated along eastern southeast Alaska (Juneau, Petersburg, Wrangell and Ketchikan) and Sitka. These are also the major population centers. Ideally, fish farms would locate within three to four hours by boat from logistic centers to minimize the amount of time that harvested fish are in transit prior to boarding flights to market areas.

The following areas would be favoured for development in terms of their proximity to population centers, airports and processing plants:

- . along the eastern half of southeast Alaska near Juneau, Ketchikan and Petersburg/Wrangell;
- . along the western side of Baranof Island near Sitka;
- . in southcentral Alaska near Kodiak, Homer, Seward, Cordova, Valdez and Whittier.

4.3 Growth and Conversion Rates

4.3.1 Generalized Temperature Regimes

The temperature data reviewed for South Central and southeast were used to develop four generalized temperature regimes in which salmon culture might take place:

- . relatively cool winter temperatures and warm summer temperatures (that might occur in bays in southcentral Alaska and near Juneau);
- . relatively warm winter temperatures and warm summer temperatures (that might occur in bays near Ketchikan);
- . relatively warm winter temperatures and cooler summer temperatures (that might occur in the Frederick Sound/Petersburg area); and
- . relatively cool winter temperatures and cool summer temperatures (that might occur in the northern inlets of southeast Alaska close to iceberg areas).

Clearly, general good-case and poor-case growing conditions would be, respectively, warm winter/warm summer conditions and cool winter/cool summer conditions. Since specific conditions can vary from site to site and from year to year, extreme best case and worst case conditions would likely lie outside these general scenarios.

Probable monthly growth rates for chinook were developed for a scenario of relatively warm winter temperatures and warm summer temperatures that might occur in the south central portion of southeast Alaska. Chinook would likely be preferable to coho for net pen rearing in Alaska since they have shown greater survival rates than coho during longer growout periods in British Columbia (B.C. Salmon Farmers Association). The fish sizes and growth rates obtained for chinook salmon at Little Port Walter and at five locations in British Columbia, together with unpublished growth rate data from the Pacific Biological Station in Nanaimo, B.C., have been used to develop the growth profile. These are shown in Exhibit 4.1.

Juvenile chinook are assumed to be placed into saltwater in June at 7 grams. In the warm winter, warm summer temperature regime, they are projected to reach a harvestable size of at least 2 kilograms after 21 months and are projected to grow to 2.5 kilograms after 24 months in saltwater.

In the cool winter/cool summer temperature regime, chinook are projected to reach only about 1 kilogram after 24 months in saltwater. If chinook were held over a third summer and harvested in October they would still be less than 2 kilograms.

4.3.2 Feed Conversion

Feed conversion rates are influenced by environmental variables (such as temperature, salinity, photoperiod, oxygen concentration) and operational variables (such as fish size, ration, food quality). Food conversion efficiency is normally greater for smaller fish sizes, decreasing as the fish grow (Brett and Groves, 1979). Over a given temperature range, on the other hand, food conversion efficiency usually reaches a maximum at a particular temperature and is lower at both lower and higher temperatures. Similarly, the optimum ration amount for maximum food conversion is normally lower than the maximum ration that the fish will consume. In turn, maximum conversion efficiency occurs at a lower ration quantity, as temperature is reduced below the optimum. Generally, optimum feed conversion efficiency for salmon appears to occur at temperatures between 10°C and 15°C at ration levels at 60-90% of maximum.

EXHIBIT 4.1: ESTIMATED GROWTH RATES FOR CHINOOK SALMON GROWN UNDER TWO
GENERALIZED MEAN MONTHLY TEMPERATURES REGIMES IN SOUTHEAST
ALASKA

	WARM WINTER/WARM SUMMER				COOL WINTER/COOL SUMMER			
	Temp.	Approx. Size (grams)	Daily Growth Rate (%)	Food Conver- sion	Temp.	Approx. Size (grams)	Daily Growth Rate (%)	Food Conver- sion
June	10.0	13	2.2	1.5	8.0	12	2.0	1.7
July	11.0	25	2.1	1.5	9.5	24	2.1	1.7
August	12.0	49	2.2	1.5	9.5	45	2.1	1.7
September	10.5	92	2.1	1.5	8.5	79	1.9	1.7
October	7.5	125	1.0	1.7	7.5	108	1.0	1.9
November	5.0	149	0.6	1.7	5.0	125	0.5	1.9
December	3.5	174	0.5	1.7	3.5	133	0.2	1.9
January	5.0	197	0.4	1.7	3.5	142	0.2	1.9
February	5.0	222	0.4	1.6	3.0	146	0.1	1.8
March	4.5	243	0.3	1.6	5.0	165	0.3	1.8
April	5.0	266	0.3	1.6	5.0	165	0.3	1.8
May	6.0	301	0.4	1.6	6.0	187	0.4	1.8
June	10.0	406	1.0	1.7	8.0	237	0.8	1.9
July	11.0	570	1.1	1.7	9.5	323	1.0	1.9
August	12.0	851	1.3	1.7	9.5	439	1.0	1.9
September	10.5	1181	1.1	1.7	8.5	575	0.9	1.9
October	7.5	1512	0.8	1.9	7.5	736	0.8	2.0
November	6.0	1704	0.4	1.9	5.0	805	0.3	2.0
December	5.5	1870	0.3	1.9	3.5	830	0.1	2.0
January	5.0	1990	0.2	1.9	3.5	856	0.1	2.0
February	5.0	2104	0.2	3.0	3.0	881	0.0	2.1
March	4.5	2170	0.1	2.0	3.0	908	0.0	2.1
April	5.0	2236	0.1	2.0	5.0	936	0.1	2.1
May	6.0	2454	0.3	2.0	6.0	1027	0.3	2.1

For potential sites in Alaska having similar temperatures and salinities to those in British Columbia (e.g., the north B.C. coast site), similar conversion rates could be expected. However, potential locations in southeast Alaska will likely have winter temperatures lower than those experienced in British Columbia (i.e., less than 5°C). Food conversion rates under these conditions will be slightly poorer than for comparably sized fish grown at higher temperatures.

Also the feed conversions obtained from dry feeds at British Columbia sites were mainly under conditions of moderate salinity. Similar conditions can be expected in areas of southeastern Alaska, particularly along the mainland side. However, along the western side, salinities could, on average, be higher. The feed conversion efficiency of dry feeds could be reduced at high salinities (greater than 25%) given higher energy requirements for osmoregulatory functions (Shaw et al, 1975; Brett, 1979).

Probable feed conversions for dry feeds utilized in southeastern Alaska for the two temperature regimes are also shown in Exhibit 4.1. These feed conversions have been adjusted to reflect a decrease in feed conversion efficiency as the fish increase in size, and decreases that might occur at seasonally lower temperatures.

4.3.3. Summary

Large areas of southcentral and southeast Alaska are not suitable for salmon culture due to the presence of ice, icebergs and large river systems. Salinities are generally more consistent throughout the year in areas away from mainland waters, where blooms are also less likely to occur.

Smolt production capacity in both southcentral and southeast Alaska is likely adequate to meet potential demand from a salmon farming industry.. Some fish feed production capability exists in southcentral, however fish feed would most likely be imported from Washington State or British Columbia because of more specialized production in these regions.

The following areas would be favoured for development in terms of their proximity to population centers, airports and processing plants:

- . along the eastern half of southeast Alaska near Juneau, Ketchikan and Petersburg/Wrangell;
- . along the western side of Baranof Island near Sitka;
- . in southcentral Alaska near Kodiak, Homer, Seward, Cordova, Valdez and Whittier.

Netpen operations in these areas would also be less likely to be affected by phytoplankton blooms. However, all areas are likely to be affected by predators.

The area around Ketchikan is probably the best area for development of pen rearing of salmon in Alaska because of warmer summer and winter temperatures. This area also has more constant salinities throughout the year. Chinook could be expected to reach a harvestable size of two kilograms during the second winter in saltwater. However, the Ketchikan area would have lower growth rates and higher conversion rates than in most areas of British Columbia where salmon farming occurs because of seasonally lower water temperatures.

A profile of a salmon farm can now be developed to allow comparison to costs in other supply regions by assuming that the growth of chinook in this area would approximate that of the warm winter/warm summer condition shown in Exhibit 4.1. Costs for major inputs such as smolts, feed and labour will be estimated for this area.

4.4 Estimated Costs of Production

4.4.1 Production Plan

Scale and Location

The analysis is undertaken for a fish farm raising chinook salmon at an annual production level of 250 tonnes, or the same at British Columbia.

The farm is assumed to be located in the Ketchikan area.

Capital Investment

Capital investment is assumed to be similar to that of British Columbia. However, cage systems and equipment are assumed to be imported and slightly more expensive. The estimated total capital investment for the farm is shown below.

	U.S. \$
Sea cage system and equipment	\$380,000
Facility on floating barge with equipment	<u>250,000</u>
	\$630,000

The total capital investment is \$2,520 per tonne. Like British Columbia accommodation and other facilities are assumed to be on a floating barge due to the lack of extensive road systems in the south central portion of southeast Alaska.

Operating Expenses

The estimated operating costs are based on the following assumptions:

- 140,000 salmon smolts at 7 grams are set out every year in June
- smolts are assumed to be supplied from Alaskan hatcheries
- the smolt price of \$0.54 is the same at that of British Columbia except without the BCSFA levy
- feed is imported from Washington State by barge and the feed standard price is \$1.01 per kg
- the feed conversion ratio is slightly higher than British Columbia and ranges between 1.5:1 and 2.0:1
- processing costs of \$0.52 per kg are slightly lower than British Columbia because of lower labour rates in the processing sector
- stock insurance, farm wages and fixed costs are comparable to British Columbia
- harvesting occurs after 20 to 24 months in saltwater
- average weight of fish is 2.5 kg at harvest (this assumes slightly better growth than that shown in Exhibit 4.1).

With these assumptions, the farm will be capable of producing about 73,500 fish for a total production of 250 tonnes per year.

Depreciation is based on the following assumptions:

Buildings	20
Seapen system and equipment	6
Site investments	50

The economic life of fixed assets is assumed to be similar to that of British Columbia, Norway and Scotland.

Unit Costs

Unit costs are shown in Exhibit 4.2. Unit costs are \$4.49 per kilogram.

EXHIBIT 4.2: ESTIMATED UNIT COSTS PER KG FOR CHINOOK SALMON
IN ALASKA

	Unit Costs (US Dollars)	%
Variable Costs		
Smolts	0.40	9
Feed	2.00	45
Stock Insurance	0.07	2
Processing	0.52	11
Interest on Working Capital	<u>0.27</u>	<u>6</u>
Total Variable Costs	3.26	73
Fixed Production Costs		
Wages	0.32	7
Overhead	0.24	5
Depreciation	0.49	11
Interest	<u>0.18</u>	<u>4</u>
Total Fixed Costs	1.23	27
Unit Costs per Kilogram	4.49	100%

Source: The DPA Group Inc.

Assuming a yield factor of about 85%, unit costs on a dressed weight basis would be \$5.28/kg or \$2.40/lb.

5.0 SUMMARY

In order to assess Alaska's potential competitiveness with other supply regions, the landed costs of production in major markets must be compared. In order to do so, we first determine selling and freight costs per unit. These are shown in Exhibit 5.1.

EXHIBIT 5.1: SHIPPING AND SELLING COSTS PER LB TO MAJOR MARKETS^a (U.S. DOLLARS)

	Supply Region					
	Norway	Scotland	B.C.	Chile	Japan	Alaska
Selling Costs	0.06	0.11	0.14	0.14	0.14	0.14
Freight to shipping point	<u>0.05</u>	<u>0.07</u>	<u>0.10</u>	<u>0.09</u>	<u>0.04</u>	<u>0.09</u>
	0.11	0.18	0.24	0.23	0.18	0.23
Additional Freight ^b to:						
Los Angeles	1.14	1.14	0.12	0.73	N/A	0.14
New York	0.80	0.80	0.50	0.73	N/A	0.55
Tokyo	1.59	1.59	0.95	1.45	as above	0.73

^a Shipping and selling costs are current to March, 1988.

^b All shipments were assumed to be air freighted to their destinations, except for shipments from B.C. to L.A. which were assumed to be trucked. The bulk rate for fresh fish or an LD3 container rate from current tariff sheets were used for shipments by air. No allowances were made for ice in containers since the increased costs associated with ice can often be offset by volume discounts.

Selling costs in Norway are less than other regions because of the participation of the Fish Farmers Sales Organization. Scotland's selling costs are also less because of a higher level of vertical integration.

With regard to the major exporters, freight costs from Norway and Scotland to major markets are comparable. British Columbia has the best freight cost advantage to Los Angeles and New York. However, Alaska has the lowest freight cost to Japan.

The landed costs of farmed salmon from each major supply region and from Alaska in three major markets is shown in Exhibit 5.2.

EXHIBIT 5.2: COMPARISON OF LANDED COSTS PER LB IN MAJOR MARKETS
 (U.S. DOLLARS)

Market	Supply Region					Alaska
	Norway	Scotland	B.C.	Chile	Japan	
Los Angeles	3.80	4.17	2.06	2.63	N/A	2.77
New York	3.46	3.83	2.44	2.63	N/A	3.18
Tokyo	4.25	4.62	2.89	3.85	3.21	3.36

As indicated in the exhibit, Alaska is competitive from a cost standpoint in all markets.

However, as previously indicated, costs at an industry level are only known for Norway. As a result, the cost comparisons should be viewed with caution. Alaska would be selling farmed salmon in smaller sizes than Norway, Scotland and British Columbia and would compete more directly with Chile. British Columbia and Chile have cost advantages over Alaska in both Los Angeles and New York.

Alaska would also likely have a short window period in which to sell. This would also likely result in more direct competition with the Chileans.

As discussed in Section 3.7, landed costs in major markets are sensitive to exchange rates. Fluctuating exchange rates could make Alaskan farmed salmon more or less competitive in all markets. However, the U.S. and Canadian currencies are closely linked and generally shift from each other only slowly. As a result, British Columbia would likely have cost advantages over Alaska in all major markets.

REFERENCES

- DPA Group Inc. Worldwide Farmed Salmon Production Forecasts to the Year 2000, Department of Fisheries and Oceans, 1988.
- Bjorndal, T., Fiskeoppdretts - okonomi (Economics of Aquaculture, Oslo: Cappelen (In Norwegian), 1987.
- Salvanes, K., "The Structure of the Norwegian Fish Farming Industry: An Empirical Analysis of Economics of Scale", Discussion paper No. 3/87, Institute of Fisheries Economics, Norwegian School of Economics and Business Administration, 1987.
- Shaw, S.A., and Muir, J.F., Salmon: Economics and Marketing, London: Croom Helm, 1987.
- Irish Sea Fisheries Board, The Atlantic Salmon Farming Industry -- Past Performance and Future Potential, 1986.
- DPA Group Inc. Industrial Organization of the B.C. Salmon Farming Industry, Department of Fisheries and Oceans, 1986.
- Gotfrit, C. Wurmman, La Industria de Salmon en Chile: Realidad Y Perspectivas, Fundacion Chile, 1987.
- Zamorano, R. Mendez, Desarrollo Y Estado de Situacion Actual De La Salmonicultura en Chile, Subsecretaria de Pesca, Chile, 1987.
- Sato, M., Technical Information on Mariculture of Salmonids in Japan, National Federation of Fisheries Cooperative Associations, 1987.

APPENDIX A

METRIC CONVERSION RATES

APPENDIX A

Metric Conversion Rates

1 kilogram = 2.2046 pounds

1 Kilogram = 1,000 grams

454 grams = 1 pound

1 metric tonne = 2204.6 pounds

1 metric tonne = 1,000 kilograms

1 metric tonne = 1.1 ton

1 metre = 1.1 yards

1 kilometre = 1,000 metres

1 kilometre = 0.62 miles

APPENDIX B

PROFITABILITY STUDY OF
FISH FARMS IN NORWAY, 1984

Production cost per kilo farmed salmon, 1984. Figures in 1984 kroner.

	Size of facility			
	Under 3.000 m ³	3.000-4.999 m ³	5.000-6.999 m ³	7.000 m ³ & over
Smolt	7.93	5.45	6.82	5.97
Feed	10.99	9.97	10.98	10.57
Other variable cost	0.60	0.69	0.62	0.58
Wages	6.51	5.06	4.82	4.80
Total variable costs	26.03	21.17	23.24	21.87
Fixed operating costs	3.77	3.38	4.37	4.16
Depreciation	1.42	1.40	1.43	1.61
Interest ^{a)}	2.65	3.03	3.18	3.10
Total	33.87	28.98	32.22	30.74
Production (tonnes)	28.30	69.80	101.20	141.10
Man-years per farm	1.59	2.50	3.98	5.07
Sample size	19	31	20	27

a) Interest includes interest on debt and calculated interest on equity.

Source: Directorate of Fisheries: Profitability Study of Fish Farms, 1984.

APPENDIX C

POTENTIAL DEVELOPMENT AREAS
FOR SALMON FARMING IN ALASKA:

TECHNICAL SUMMARY

Prepared for:
State of Alaska
Department of Commerce
and Economic Development
Juneau, Alaska

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March, 1988

TABLE OF CONTENTS

	Page
1.0 INTRODUCTION	1-1
2.0 ENVIRONMENTAL AND LOGISTIC CONDITIONS	2-1
2.1 Introduction	2-1
2.2 Physical Marine Conditions	2-1
2.3 Phytoplankton and Marine Mamals	2-9
2.4 Smolt Production Capabilities	2-10
2.5 Potential Development Areas	2-12
2.6 Summary	2-14
3.0 GROWTH AND CONVERSION RATES	3-1
3.1 Generalized Temperature Regimes	3-1
3.2 Growth Rates	3-1
3.3 Feed Conversion	3-7
3.4 Summary	3-10
REFERENCES	

1.0 INTRODUCTION

The purpose of this study is to determine the feasibility of pen-rearing salmon in Alaska. The approach is to develop likely costs of production for pen-rearing of salmon in Alaska and compare these costs to those of existing supply regions.

Development of likely costs of production in Alaska requires an analysis of conditions for rearing. British Columbia is emerging as a major supply region and is considered the best model for analysis of Alaska's potential.

This technical report summarizes the following:

- . general environmental and logistic conditions for pen-rearing salmon in Alaska;
- . differences in growth and feed conversion rates between British Columbia and Alaska.

In order to assess conditions for pen rearing salmon in Alaska we conducted reviews of previous environmental studies in Alaska. We also held telephone interviews with several fisheries officials in the state of Alaska Department of Fish and Game and the National Marine Fisheries Service.

In order to develop growth data and feed conversion ratios we compared published results of the National Marine Fisheries Service salmon farming research projects at Little Port Walter and Auke Bay to those of a recent broodstock management program in British Columbia.

In the following section of the report we determine areas suitable for pen-rearing salmon in Alaska. In section 3.0 we estimate growth and conversion rates. Also, in this section we describe how the analysis of the potential for pen-rearing salmon in Alaska from a biophysical standpoint will be used to determine its economic viability.

2.0 ENVIRONMENTAL AND LOGISTIC CONDITIONS

2.1 Introduction

Conditions which are important in considering the location of a netpen site can be classified under environmental or logistic categories.

Environmental factors include water quality characteristics and potential problems with plankton blooms and predators. Logistic factors include access to critical inputs such as smolts, feed, labour and transportation routes.

These conditions are discussed below.

2.2 Physical Marine Conditions

This section contains an overview of ice formation and iceberg conditions, temperatures and salinities in southcentral and southeast Alaska. According to fisheries officials contacted, these are the two areas where development of net pen-rearing would most likely occur. The information is then used to develop assumptions about growing conditions, growth rates and feed conversions.

Southcentral Alaska

Ice Formations and Icebergs

Ice formation and the presence of icebergs in embayments and low winter air temperatures impose constraints on development of netpen sites in southcentral Alaska; in particular, these are:

- . the presence of pack ice and fast ice in Cook Inlet;
- . the presence of ice and icebergs in embayments connected to Prince William Sound and near Seward; and
- . the potential for ice formation on floating structures.

LaBelle et al (1983) indicate that during late December open pack ice can normally be expected along Cook Inlet between the head of the inlet and a line approximately between Cape Douglas and a point just south of Ninilchik. At times, close pack ice can extend further to a line approximately between Cape Douglas and Homer. Within Prince William Sound, LaBelle et al (1983) indicate that icebergs from glaciers can normally be encountered in the vicinity of Glacier Island (at the mouth of Valdez Arm), in Unakwik Inlet and Port Wells (between Valdez Arm and Whittier), in Blackstone Bay (to the south of Whittier), in the head of Port Nellie Juan and in Knight Island Pass (to the south of Port Nellie Juan). Near Seward they indicate icebergs are present in Aialik Bay and Harris Bay (southwest of Seward) and in the East Arm of Nuka Bay.

Apart from the presence of sea ice and glacier ice in embayments in southcentral Alaska, the air temperature and wind conditions in that area make it generally susceptible for ice formation on floating structures (La Belle *et. al.* 1983).

Water Temperatures

Mean monthly sea surface water temperatures are summarized in Exhibit 2.1. These data suggest that, in general, mean winter surface temperatures can be expected to be approximately 2.5 - 5.0°C and mean summer surface temperatures can be expected to be approximately 0 - 13°C.

Surface temperatures are often recorded as routine measurements because they are easier to measure than temperatures at greater depths. However, salmon are suspended in structures that place them below the surface, but in the upper 6-10 m of the water column (depending on the net depth selected by individual operators). Therefore, subsurface temperatures (between 0 and 10 m) are usually more appropriate for determining the growing conditions for salmon. Temperatures recorded at 10 m near Seward are also shown in Exhibit 2.1. These data indicate that at that depth mean spring and early summer temperatures are slightly lower than the surface temperatures, while mean fall and winter temperatures are approximately the same.

EXHIBIT 2.1: SUMMARY OF MONTHLY SEA SURFACE TEMPERATURE IN SOUTHCENTRAL ALASKA

Month	Coastal ¹		Seward ²	
	Kodiak-Cook Inlet	Prince William Sound	0 Meters	10 Meters
January	4.0	4.5	4.0	4.0
February	3.0	5.0	4.0	4.0
March	4.0	4.0	2.8	2.8
April	4.0	5.0	3.3	3.3
May	5.0	6.0	6.0	5.4
June	7.0	9.0	9.2	7.0
July	9.0	11.5	12.9	10.8
August	11.5	12.5	12.8	12.8
September	10.5	12.0	11.4	11.7
October	9.0	9.0	7.6	8.2
November	7.0	8.0	7.0	7.1
December	5.5	6.0	5.0	6.0

¹ Estimates based on isopleths and cumulative percent frequency graphs

² Based on graphed monthly means, 1979-1983.

Source: Brower *et. al.* 1977; Xiong and Royer 1984.

Salinity

Xiong and Royer (1984) state that average surface salinities in summer are 27.3‰ and in winter are 3.12‰ based on intensive studies near Seward. At greater depths (i.e. 250 m), salinities are approximately 33‰ year round. Colonell (1980) and Muench and Nebert (1973) describe the presence of relatively fresh water lying in a thin surface layer in Valdez Arm and Port Valdez during summer and autumn. Muench and Nebert (1973) indicate that minimum mean surface salinities (0-125 m) were approximately 3‰ over the July - October period, though salinities in the upper 20 m were, at times, less than 1‰ near the head of Port Valdez (in late July/early August). Lower surface salinities over the summer period are attributed to freshwater runoff from land areas and high precipitation.

Southeast Alaska

Icebergs

Icebergs are present in several bays and straits in northern and eastern Southeastern Alaska (LaBelle *et al*, 1983).

- . Cross Sound, Icy Strait and Glacier Bay;
- . Taku Inlet;
- . Tracy Arm and Endicott Arms; and
- . the end of Frederick Sound.

The presence of icebergs suggests a potential for damage to floating structures and, in general, these areas should be avoided. Also, the icebergs apparently can greatly reduce summer temperatures in surface waters (Pickard, 1967).

Water Temperatures

Mean monthly surface temperatures for the coastal waters along southeast Alaska (Brower *et al*, 1977) are presented in Exhibit 2.2. Mean surface temperatures recorded at five lighthouse installations (Jones, 1978) in southeast Alaska and in Auke Bay near Juneau (Bruce *et al*, 1977) are also summarized.

These data show mean high temperatures in summer (August) to range between 9.0°C (Decision Rock) and 14.6°C (Guard Island). Mean low temperatures in winter (February/March) range between 2.3°C (February at Point Retreat) and 5.2°C (February at Lincoln Rock). The mean low temperature for the general coastal area (Brown *et al*, 1977) is slightly higher than these values at 6.0°C. The Five Fingers location is at the junction of Stephens Passage and Frederick Sound. The cooler summer temperatures at the Five Fingers location (and possibly further westward at Decision Rock) could reflect the cooling influence of glaciers in Stephens Passage and Frederick Sound. Pickard (1967) notes that Stephens Passage appears to receive considerable freshwater from the Taku River and Juneau Icefield and that flow from Stephens Passage

could influence water property features at its junction with Frederick Sound. He also notes that water in the eastern portion of Frederick Sound is cool in summer as a result of nearby glaciers. Pickard (1967) reported average temperatures of 6.7°C for Stephens Passage and 3.0°C for Frederick Sound in the upper 10 m of water during August, 1965. Average temperatures in other locations range from approximately 4.0°C (in inlets containing icebergs, for example, Tracy and Endicott Arms along Stephens Passage and Glacier Bay) to approximately 12-14°C in other locations (such as Lynn Canal, near Juneau and Boca de Quadra, near Ketchikan).

EXHIBIT 2.2: SUMMARY OF MEAN MONTHLY SEA SURFACE TEMPERATURE IN SOUTHEAST ALASKA

Month	Coastal ¹	Guard Island	Lincoln Rock	Decision Light	Five Finger Light	Point Retreat	Auke Bay
January	6.5	5.2	4.4	3.9	3.6	2.6	3.2
February	6.5	4.9	5.2	4.2	3.0	2.3	2.5
March	6.0	5.2	5.3	4.5	3.4	2.9	3.0
April	6.5	6.2	6.2	5.1	4.3	3.6	4.8
May	8.0	8.3	8.1	6.0	5.4	4.9	8.0
June	10.0	12.4	11.4	7.1	7.8	8.5	12.0
July	12.5	14.5	12.8	9.2	9.6	11.4	13.2
August	13.0	14.6	13.6	9.0	9.6	12.3	13.5
September	12.5	12.9	11.5	8.7	8.1	10.2	11.0
October	10.5	10.4	9.3	7.5	6.5	7.3	7.2
November	9.0	7.8	6.7	5.6	5.5	5.3	5.0
December	7.5	5.9	5.1	4.0	4.2	3.7	4.5

¹ Estimates based on isoplaths and cumulative percent frequency graphs

Source: Brower et. al. 1977; Bruce et al. 1977; Jones 1978.

In general, winter temperatures are lower, as expected, and show less variation amongst locations (compared to summer values); with a trend from south to north of approximately 4.5 - 5.0°C in southern locations (i.e., near Ketchikan) to 2.5 - 3.0°C in more northern locations (i.e., near Juneau).

As described previously, surface temperatures are commonly recorded as routine measurements because they are easier than temperatures taken at greater depths. Temperatures can differ between surface and greater depths in southeast Alaska, particularly over the summer (Bruce et al., 1977; Pickard, 1967). Bruce et al. (1977) show little difference over the fall, winter and spring period between the surface and 5 m but show water at a 5 m depth to be 2.0 - 3.0°C cooler in summer (July). Pickard (1967) shows a similar

trend amongst vertical depth profiles developed for inlet site samples in August, 1965. Data recorded by the National Marine Fisheries Service for several years at facilities in Auke Bay near Juneau and Little Port Walter on Baranof Island are summarized in Exhibit 2.3. These data suggest winter temperatures at 4 - 5 m are similar to surface measurements near those locations (see Exhibit 2.2). However, the summer temperatures at the greater depth appear to be several degrees cooler than surface temperatures in Auke Bay (as noted above). The temperatures at Little Port Walter appear to be similar to surface measurements recorded nearby (e.g. Decision Light shown in Exhibit 2.2). The August data in Pickard (1967) indicate lower surface temperatures (9°C) in portions of Chatham Sound (where Little Port Walter is located) south of its junction with Frederick Sound, compared to locations further north (e.g., near Angoon) where surface temperatures were approximately 12°C.

**EXHIBIT 2.3: SUMMARY OF AVERAGE MEAN MONTHLY TEMPERATURES
RECORDED AT 4-5 M DEPTHS AT AUKE BAY AND LITTLE
PORT WALTER**

Month	Auke Bay ¹	Little Port Walter ²
January	4.5	5.2
February	3.0	5.0
March	3.0	5.4
April	4.0	4.8
May	6.5	5.6
June	10.0	8.1
July	12.0	9.6
August	12.0	9.4
September	11.0	8.4
October	9.5	7.3
November	6.0	5.8
December	3.5	5.4

¹ Approximations based on averaged graphical data, 1960-68.

² Average mean monthly temperatures, 1984-1987.

Sources: Bruce et al. 1977, Thrower pers. comm.

Salinities

Larger rivers along the mainland shoreline can produce lower and fluctuating salinities (Pickard, 1967) and consequently make nearby areas unsuitable for locating netpens for adult growout. These areas include the mouths of the Stikine River, Taku River, Unuk River, Chilkat River and Speel River.

Lower and fluctuating salinities can affect the physiological condition of the salmon (i.e. in relation to the osmoregulatory adaptation to ambient salinity levels) and could influence outbreaks of harmful phytoplankton.

Pickard (1976) shows that most larger rivers in southeast Alaska (e.g. Stikine, Taku, and Chilkat) have peak flows over the summer period from melting glaciers and snow packs. Smaller rivers either have high flows in both summer and fall/early winter (from precipitation) or high flows primarily in fall/early winter. Low flows for all systems generally occur over late winter and early spring.

As a result, one would expect:

- generally higher surface salinities during late winter and early spring; and
- generally lower surface salinities and greater fluctuation in salinities, in waters closer to the mainland (where most large and moderate-sized river systems are located) relative to seaward coastal areas.

In general, Pickard (1967) found surface salinities over the summer in inlets without icebergs were lower at the head ends (range 1-11‰ compared to the inlet mouths (range of 17-32‰). Salinities in deeper waters during summer ranged from 31.2 to 34‰, which are similar to surface values recorded at ocean recording stations off the western shore of southeast Alaska.

Bruce et al (1977) indicate that in Auke Bay, surface salinities are typically much lower (16-17‰) in summer (July) than in winter and early spring (30‰ January and April), and in winter/early spring are similar to deep water values (30-31‰). They also show that at depths of 5 m, the summer values (20-21‰) are typically more saline than surface values. Lower summer surface salinities are attributed to peak runoff from nearby large, glacial-fed streams. At Little Port Walter (which is located further from the mainland streams), mean monthly salinities at 4 m depth are generally higher ranging from 26-30‰ in summer/early fall to 31-33‰ in winter. Pickard (1967) shows high surface salinities (greater than 30‰) in southern Chatham Sound (near Little Port Walter), Sumner Sound and Clarence Strait, recorded during June and August.

2.3 Phytoplankton and Marine Mammals

Phytoplankton

Two phytoplankton species, Chaetoceros convolutus and Heterosigma akashiwo, have caused serious mortalities amongst salmon cultured in marine netpens in British Columbia. Conditions appear suitable for both species in southcentral and southeast Alaska (Gaines and Taylor, 1986). Chaetoceros

diatoms have been responsible for chinook salmon mortalities in seapens at Little Port Walter (National Marine Fisheries Service, unpublished). Chaetoceros convolutus has also been collected during surveys near Valdez in Prince William Sound (Horner et al 1973.) The occurrence and intensity of phytoplankton blooms vary greatly both geographically and temporally and prediction is difficult (Gaines and Taylor, 1987). In general, Heterosigma blooms tend to occur in early summer, often in association with lower salinities resulting from increasing river flow, while Chaetoceros blooms tend to occur in the late summer or fall.

Harmful phytoplankton could affect sites in both southcentral and southeast Alaska. As in British Columbia, the effects on production could be direct mortalities or reduced growth when oxygen depletion occurs and rations are restricted. In British Columbia, the strategy in stocking is to maintain densities at low levels (e.g., less than 8 kg/m³) to minimize losses should bloom conditions occur.

Marine Mammals

Marine mammals such as otters and sea lions have affected production at sites in British Columbia by killing fish in pens, by damaging netpens allowing fish to escape, and by causing high stress levels in the fish thereby reducing growth rates. National Marine Fisheries Service (unpublished) indicate otters, seals and possibly sea lions have killed fish at the experimental facilities near Little Port Walter. Steller's sea lions and harbour seals occur essentially along the entire Gulf of Alaska coastline (U.S. Department of the Interior, 1984).

Predation from marine mammals will likely be a similar problem in southcentral and southeast Alaska waters to that which occurs in British Columbia. This would likely require investment in predator control measures such as predator nets. Again, density levels would be kept low so that if stress develops when predators are nearby (but do not necessarily attack fish in the pens) it will not compound stress already resulting from high densities.

2.4 Smolt Production Capabilities

Southeast Alaska

Four state hatcheries in southeast Alaska produce chinook salmon and three hatcheries produce coho salmon (Hansen, 1987):

Hatchery	Location	Species Reared
Snettisham	near Juneau	chinook, coho
Hidden Falls	northeastern Baranof Island	chinook
Crystal Lake	near Petersberg	chinook, coho
Deer Mountain	near Ketchikan	chinook
Klawock	near Craig	coho

In 1986, nearly 5 million chinook eggs were collected from these facilities and more than 2.7 million juvenile chinook were released. Similarly, slightly more than 4 million coho eggs were collected and 1.5 juvenile coho were released.

In addition, 10 private non-profit hatcheries operated by regional aquaculture associations and other non-profit groups raise chinook or coho or are permitted to raise these species:

Hatchery	Location
Whitman Lake, Neets Bay, Meyers	
Chuck and Burrard Inlet	near Ketchikan
Gunuk Creek	near Petersburg
Medvejie Creek, Sheldon	
Jackson College and Port Armstrong	near Sitka
Salmon Creek and Sheep Creek	near Juneau

In 1986, private non-profit hatcheries in southeast Alaska had total permitted chinook egg capacities of 6.73 million and total permitted coho egg capacities of 15.47 million eggs. Most fry production of both species is in the Whitman Lake and Neets Bay hatcheries operated by the Southern Southeast Regional Aquaculture Association.

Southcentral Alaska

Five state hatcheries in southcentral Alaska produce chinook salmon and five hatcheries produce coho salmon:

Hatchery	Location	Species Reared
Big Lake	near Anchorage	coho
Fort Richardson	near Anchorage	coho, chinook
Elmendorf	near Anchorage	coho, chinook
Trail Lake	near Seward	coho, chinook
Kitoi Hatchery	near Kodiak	chinook, coho.

In 1986, 1.5 million chinook eggs were collected and 1.5 million juvenile chinook were released. Slightly more than 6.5 million coho eggs were collected and 7 million coho juveniles were released.

Three private non-profit hatcheries operated by regional aquaculture associations and other non-profit groups raise chinook or coho salmon or are permitted to raise these species:

Hatchery	Location
Eklutna	near Anchorage
Esther Lake	near Whittier
Solomon Gulch	near Valdez

In 1986, the private non-profit hatcheries had total permitted chinook egg capacities of 1.15 million and total permitted coho egg capacities of 3.1 million. Clearly, a large smolt production capability exists in both southcentral and southeast Alaska and this production is spread throughout each region. Hansen (1987) indicates that a number of hatcheries are constructed below lakes and water intakes in the lakes are placed at different depths so temperatures can be adjusted. This means juvenile growth rates and smolt timing can be manipulated to achieve release objectives.

2.5 Fish Feed

Currently there is fish feed production capacity in southcentral. However, capacity is limited and technologies employed in production are not as advanced as those in Europe, British Columbia or Washington State.

The main ingredients in commercial fish feeds are fish meal and fish oil. These are manufactured in the reduction process from whole fish or fish waste from the processing sector. Alaska's reduction industry is not well developed, despite the availability of significant quantities of fish waste. In addition the reduction plants in Alaska produce fish meal and fish oil which is unsuitable for fish feed. According to representatives of a fish feed manufacturer in Washington State, if a new feed plant were to be constructed, it would likely be constructed in tandem with a new reduction plant, both of which require significant capital investment. Alaska would more likely be supplied by fish feed manufacturers in Washington State or British Columbia since transport by barge to Alaska is not a significant cost.

2.6 Potential Development Areas

As discussed previously, certain areas of southcentral and southeast Alaska are not suitable for salmon culture given the presence of ice, icebergs and large river systems. Therefore, initial development would be expected to occur in suitable bays or shoreline areas (protected from high winds or waves) away from these areas and as close to transportation centers and processing/packing facilities as possible.

Small to medium-sized communities having airport and port facilities are distributed throughout both southcentral and southeast Alaska. The population sizes of coastal communities in the lower Cook Inlet, Kodiak Island and Prince William Sound areas are shown in Exhibit 2.4. Apart from the major airport in Anchorage, smaller airfields and port facilities are located throughout the area (e.g., Homer and Seward).

Larger airports and port facilities are situated along eastern southeast Alaska (Juneau, Petersburg, Wrangell and Ketchikan) and Sitka. As shown in Exhibit 2.4, these are also the major population centers. Ideally, new fish farms would want to locate within three to four hours by boat from logistic centers to minimize the amount of time that harvested fish are in transit prior to boarding flights to market areas. This would tend to create development in physically suitable areas along the eastern half of southeast Alaska (near Juneau, Ketchikan and Petersburg/Wrangell) and along the western side of Baranof Island (near Sitka), and in southcentral Alaska (near Kodiak, Homer, Seward, Cordova, Valdez and Whittier).

2.7 Summary

Large areas of southcentral and southeast Alaska are not suitable for salmon culture due to the presence of ice, icebergs and large river systems. Salinities are generally more consistent throughout the year in areas away from mainland waters, where blooms are also less likely to occur.

Smolt production capacity in both southcentral and southeast Alaska is likely adequate to meet potential demand from a salmon farming industry. Some fish feed production capability exists in southcentral, however fish feed would most likely be imported from Washington State or British Columbia because of more specialized production in these regions.

The following areas would be favoured for development in terms of their proximity to population centers, airports and processing plants:

- . along the eastern half of southeast Alaska near Juneau, Ketchikan and Petersburg/Wrangell;
- . along the western side of Baranof Island near Sitka;
- . in southcentral Alaska near Kodiak, Homer, Seward, Cordova, Valdez and Whittier.

Netpen operations in these areas would also be less likely to be affected by phytoplankton blooms. However, all areas are likely to be affected by predators.

EXHIBIT 2.4: POPULATIONS OF COMMUNITIES IN SOUTHCENTRAL AND SOUTHEAST ALASKA (1980)

Southcentral		Southeast	
Keani/Cook Inlet		Juneau	19,528
Kenai	4,324	Sitka	7,803
Soldotna	2,320	Ketchikan	7,198
Homer	2,209	Petersburg	2,821
Seldovia	479	Wrangell	2,184
Ninilchik	341	Metlakatla	1,056
Port Graham	161	Haines	993
English Bay	124	Skagway	768
Kodiak Island/Shelikof Strait		Hoonah	680
Kodiak	4,756	Kake	555
Old Harbor	340	Craig	527
Port Lions	215	Angoon	465
Ouizinkie	173	Klawock	318
Larsen Bay	141	Hydaburg	298
Akiak	105	Saxman	273
Karluk	96	Pelican	180
Prince William Sound		Tenakee Springs	138
Valdez	3,079	Klukwan	135
Cordova	1,879	Meyers Chuck	50
Seward	1,834	Kupreanof	47
Whittier	198	Kasaan	25
Tatitlek	68		

Source: U.S. Census Population 1981 and 1982, cited in U.S. Department of the Interior 1984.

3.0 GROWTH AND CONVERSION RATES

3.1 Generalized Temperature Regimes

The temperature data reviewed in Section 2.1 (Physical Marine Conditions) have been used to develop four generalized temperature regimes (Exhibit 3.1) in which salmon culture might take place:

- . relatively cool winter temperatures and warm summer temperatures (that might occur in bays in southcentral Alaska and near Juneau);
- . relatively warm winter temperatures and warm summer temperatures (that might occur in bays near Ketchikan);
- . relatively warm winter temperatures and cooler summer temperatures (that might occur in the Frederick Sound/Petersburg area); and
- . relatively cool winter temperatures and cool summer temperatures (that might occur in the northern inlets of southeast Alaska close to iceberg areas).

Clearly, general good-case and poor-case growing conditions would be, respectively, warm winter/warm summer conditions and cool winter/cool summer conditions. Since specific conditions can vary from site to site and from year to year, extreme best case and worst case conditions would likely lie outside these general scenarios.

EXHIBIT 3.1: GENERALIZED MEAN MONTHLY TEMPERATURES AT 4 M DEPTHS

Month	Cool Winter/ Warm Summer	Warm Winter/ Warm Summer	Warm Winter/ Cool Summer	Cool Winter/ Cool Summer
January	.5	5.0	5.0	3.5
February	3.0	5.0	5.0	3.0
March	3.0	4.5	4.5	3.0
April	5.0	4.5	4.5	3.0
May	6.0	6.0	6.0	6.0
June	10.0	10.0	8.0	8.0
July	11.0	11.0	9.5	9.5
August	12.0	12.0	9.5	9.5
September	10.5	10.5	8.5	8.5
October	7.5	7.5	7.5	7.5
November	5.0	6.0	6.0	5.0
December	3.5	5.5	5.5	3.5

3.2 Growth Rates

Chinook would likely be preferable for net pen rearing in Alaska since they have shown greater survival rates than coho during the longer growout periods in British Columbia needed to attain market size (B.C. Salmon Farmers Association).

The fish sizes and growth rates obtained for chinook salmon at Little Port Walter and at five locations in British Columbia are summarized in Exhibit 3.2. These data have been used together with unpublished growth rate data from the Pacific Biological Station, Nanaimo, B.C. (R. Brett, H. Kreiberg, pers. comm.) and the mean monthly temperatures shown in Exhibit 3.1 to develop probable monthly growth rates for the south central portion of southeast Alaska. Estimated maximum growth rates for different fish sizes and the temperature range expected for marine growout sites in Alaska are shown in Exhibit 3.3. Seasonal growth scenarios for the generalized good growing temperatures and poor growing temperatures (Exhibit 3.1) are shown in Exhibit 3.4. As indicated in Exhibit 3.4, the approximate size of chinook after 26 months in saltwater is 3.5 kg under good growing temperatures and 2.5 kg under poor growing temperatures. With good growing temperatures, chinook could be expected to reach a harvestable size of two kilograms during the second winter in saltwater. Most farmed salmon is sold between October and April, during the off-season of the wild fishery. With poor growing temperatures, chinook would likely have to be held over until the following fall.

EXHIBIT 3.3: ESTIMATED MAXIMUM GROWTH RATES¹ FOR CHINOOK AT DIFFERENT WEIGHTS AND TEMPERATURES

WEIGHT (g)	TEMPERATURE ^o (C)						
	2	4	6	8	10	12	14
5	0.4	0.9	1.3	1.8	2.2	2.7	3.1
10	0.3	0.7	1.0	1.4	1.8	2.2	2.5
50	0.2	0.3	0.5	0.6	0.8	1.0	1.2
100	0.2	0.3	0.5	0.6	0.8	1.0	1.2
500	0.2	0.2	0.3	0.4	0.5	0.6	0.7
1000	0.1	0.2	0.2	0.3	0.3	0.4	0.5
2000	0.1	0.1	0.2	0.2	0.3	0.3	0.4
3000	0.1	0.1	0.1	0.2	0.2	0.2	0.3

¹ Percent body weight per day.

Sources: Brett, pers. comm.; Kreiberg, 1981a; 1987b; National Marine Fisheries Service, unpublished.

EXHIBIT 3.2: MEAN MONTHLY TEMPERATURES AND GROWTH RATES FOR CHINOOK SALMON AT LITTLE PORT WATER, ALASKA AND FIVE LOCATIONS IN BRITISH COLUMBIA

MONTH	LITTLE PORT WATER			LITTLE PORT WATER			NORTH B.C. COAST			SOUTH B.C. COAST (Gulf Islands)			SOUTH B.C. COAST (Sunshine Coast)			SOUTH B.C. COAST (Pacific Biological Station)			SOUTH B.C. COAST (West Coast of Vancouver Island)		
	1982 BROOD STOCK			1984 BROOD STOCK																	
	Temp.	Size	Rate	Temp.	Size	Rate	Temp.	Size	Rate	Temp.	Size	Rate	Temp.	Size	Rate	Temp.	Size	Rate	Temp.	Size	Rate
JUNE	-	-	-	7.3	5.0	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JULY	-	-	-	9.2	-	1.7	12.1	4.5	2.7	-	4.5	2.5	18.8	4.5	3.3	18.0	4.5	2.4	-	4.5	3.2
AUGUST	-	-	-	8.8	-	1.7	12.0	-	2.7	13.8	-	2.5	16.8	-	3.3	16.8	-	2.4	16.1	-	3.2
SEPTEMBER	-	-	-	7.7	-	1.7	8.8	-	2.7	12.6	-	2.5	15.1	-	3.3	14.4	-	2.4	13.2	-	3.2
OCTOBER	-	82	0.5	6.0	-	1.7	8.8	59	2.7	11.3	50	2.5	11.9	84.0	3.3	11.3	40	2.4	11.4	129	3.2
NOVEMBER	-	-	0.5	4.4	-	0.3	6.5	-	0.6	9.6	-	0.6	9.7	-	0.6	8.0	-	0.8	9.7	-	0.6
DECEMBER	-	-	0.5	5.2	-	0.3	5.0	-	0.6	-	-	0.6	6.7	-	0.6	6.7	-	0.8	6.9	-	0.6
JANUARY	-	-	0.5	4.8	-	0.3	5.5	-	0.6	-	-	0.6	6.7	-	0.6	7.8	-	0.8	7.2	-	0.6
FEBRUARY	-	-	0.5	-	-	0.3	5.1	-	0.6	7.3	-	0.6	7.6	-	0.6	7.1	-	0.8	7.5	-	0.6
MARCH	-	-	0.5	-	-	0.3	6.0	166	0.6	-	180	0.6	7.9	208	0.8	9.0	180	0.6	8.7	286	0.7
APRIL	-	-	0.5	4.7	150	0.3	8.0	-	0.6	8.5	-	0.5	9.0	-	0.8	10.2	-	0.6	8.6	-	0.7
MAY	-	276	0.5	5.8	-	1.0	8.3	232	0.6	-	246	0.6	11.8	391	0.8	12.0	250	0.6	10.0	442	0.7
JUNE	9.0	-	0.9	7.7	-	1.0	10.9	-	0.7	12.3	-	0.9	14.9	-	1.0	15.5	-	0.7	13.2	-	0.8
JULY	10.1	636	0.9	8.7	273	1.0	12.5	-	0.7	13.4	-	0.9	16.6	-	1.0	16.8	-	0.7	16.2	-	0.8
AUGUST	10.1	-	0.9	8.3	-	1.0	13.1	-	0.7	14.7	-	0.9	16.7	-	1.0	19.0	-	0.7	16.2	-	0.8
SEPTEMBER	9.3	-	0.9	8.1	591	1.0	11.5	-	0.7	13.8	-	0.9	15.8	-	1.0	15.9	-	0.7	14.5	-	0.8
OCTOBER	8.8	946	0.9	6.8	-	-	10.2	537	0.7	11.2	931	0.9	12.1	1302	1.0	13.2	630	0.7	11.9	1317	0.3
NOVEMBER	6.5	-	0.3	6.4	-	-	8.6	-	-	10.4	-	-	9.4	-	-	10.5	-	-	11.7	-	-
DECEMBER	5.2	-	0.3	5.8	-	-	7.0	-	-	9.0	-	-	7.7	-	-	9.3	-	-	8.7	-	-

EXHIBIT 3.2: (Cont'd)

MONTH	1982 BROOD STOCK			LITTLE PORT WALTER			NORTH B.C. COAST			SOUTH B.C. COAST (Gulf Islands)			SOUTH B.C. COAST (Sunshine Coast)			SOUTH B.C. COAST (Pacific Biological Station)			SOUTH B.C. COAST (West Coast of Vancouver Island)		
	Temp. Size Rate			Temp. Size Rate			Temp. Size Rate			Temp. Size Rate			Temp. Size Rate			Temp. Size Rate			Temp. Size Rate		
	Temp.	Size	Rate	Temp.	Size	Rate	Temp.	Size	Rate	Temp.	Size	Rate	Temp.	Size	Rate	Temp.	Size	Rate	Temp.	Size	Rate
JANUARY	4.9	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FEBRUARY	5.0	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MARCH	4.6	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
APRIL	4.8	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAY	5.4	1814	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JUNE	7.3	2198	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JULY	9.2	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AUGUST	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEPTEMBER	7.7	3776	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(ASF-313/5264P)

EXHIBIT 3.4: ESTIMATED GROWTH RATES FOR CHINOOK SALMON GROWN UNDER TWO
GENERALIZED MEAN MONTHLY TEMPERATURES REGIMES IN SOUTHEAST ALASKA

	WARM WINTER/WARM SUMMER				COOL WINTER/COOL SUMMER			
	Temp.	Approx. Size (grams)	Daily Growth Rate (%)	Food Conver- sion	Temp.	Approx. Size (grams)	Daily Growth Rate (%)	Food Conver- sion
June	10.0	13	2.2	1.5	8.0	12	2.0	1.7
July	11.0	25	2.1	1.5	9.5	24	2.1	1.7
August	12.0	49	2.2	1.5	9.5	45	2.1	1.7
September	10.5	92	2.1	1.5	8.5	79	1.9	1.7
October	7.5	125	1.0	1.7	7.5	108	1.0	1.9
November	5.0	149	0.6	1.7	5.0	125	0.5	1.9
December	3.5	174	0.5	1.7	3.5	133	0.2	1.9
January	5.0	197	0.4	1.7	3.5	142	0.2	1.9
February	5.0	222	0.4	1.6	3.0	146	0.1	1.8
March	4.5	243	0.3	1.6	5.0	165	0.3	1.8
April	5.0	266	0.3	1.6	5.0	165	0.3	1.8
May	6.0	301	0.4	1.6	6.0	187	0.4	1.8
June	10.0	406	1.0	1.7	8.0	237	0.8	1.9
July	11.0	570	1.1	1.7	9.5	323	1.0	1.9
August	12.0	851	1.3	1.7	9.5	439	1.0	1.9
September	10.5	1181	1.1	1.7	8.5	575	0.9	1.9
October	7.5	1512	0.8	1.9	7.5	736	0.8	2.0
November	6.0	1704	0.4	1.9	5.0	805	0.3	2.0
December	5.5	1870	0.3	1.9	3.5	830	0.1	2.0
January	5.0	1990	0.2	1.9	3.5	856	0.1	2.0
February	5.0	2104	0.2	3.0	3.0	881	0.0	2.1
March	4.5	2170	0.1	2.0	3.0	908	0.0	2.1
April	5.0	2236	0.1	2.0	5.0	936	0.1	2.1
May	6.0	2454	0.3	2.0	6.0	1027	0.3	2.1

Growth rates normally decrease as fish increase in size and maximum growth rates occur at a temperature optimum and are therefore lower at lower temperatures and at higher temperatures (Brett, 1979). Brett et al (1982) estimated the optimum temperature for juvenile chinook salmon fed a maximum ration to be 19°C and fish fed a 60% ration to be 15°C.

In addition to temperature, growth rates can be affected by other factors including the presence of stressing factors (e.g., densities, handling, and the presence of predators), feed quality and ration level. Consequently, under commercial production conditions, maximum growth rates are often not achieved. In fact ration levels are usually reduced deliberately to obtain more cost-effective feed utilization (e.g., at 70 - 90% of maximum rations). In general, if other factors were the same in British Columbia and Alaska, the mean winter growing temperatures expected for Alaskan waters indicate winter growth rates could be substantially lower than those occurring in British Columbia cf. temperatures in Exhibit 3.2). Rates of digestion and feed consumption are highly reduced at low temperatures (1-5°C) resulting in growth rates that could be 20-40% of the maximum achievable at optimum temperatures (Brett, 1979).

3.3 Feed Conversion

Feed conversion rates are influenced by environmental variables (such as temperature, salinity, photoperiod, oxygen concentration) and operational variables (such as fish size, ration, food quality). Food conversion efficiency is normally greater for smaller fish sizes, decreasing as the fish grow (Brett and Groves, 1979). Over a given temperature range, on the other hand, food conversion efficiency usually reaches a maximum at a particular temperature and is lower at both lower and higher temperatures. Similarly, the optimum ration amount for maximum food conversion is normally lower than the maximum ration that the fish will consume. In turn, maximum conversion efficiency occurs at a lower ration quantity, as temperature is reduced below the optimum. Generally, optimum feed conversion efficiency for salmon appears to occur at temperatures between 10°C and 15°C at ration levels at 60-90% of maximum. Brett et al. (1982) found the temperature for maximum food conversion for juvenile chinook salmon fed a maximum ration to occur approximately 20-21°C but for salmon consuming 60% of the maximum ration appeared to occur at approximately 15°C.

Feed conversion rates for dry diets obtained at five farm locations in British Columbia are shown in Exhibit 3.5. For sites having similar temperatures and salinities to those in Alaska (e.g., the north B.C. coast site) similar conversion rates would be expected.

**EXHIBIT 3.5: FEED CONVERSION RATES AT FIVE MARINE SITES
GROWING CHINOOK SALMON IN BRITISH COLUMBIA**

TIME PERIOD	NORTH B.C. COAST			SOUTH B.C. COAST (Gulf Islands)			SOUTH B.C. COAST (Sunshine Coast)			SOUTH B.C. COAST (Pacific Bio- logical Station)			SOUTH B.C. COAST (West Coast of Vancouver Island)		
	5			2			3			1			4		
	Size		F.C.R.	Size		F.C.R.	Size		F.C.R.	Size		F.C.R.	Size		F.C.R.
	St.	End		St.	End		St.	End		St.	End		St.	End	
JULY - OCT. 1985	4.5	59	1.3	4.5	50	-	4.5	84	-	4.5	40	2.1	4.5	129	1.3
OCT. 1985 - MAR. 1986	59	166	1.4	50	180	1.8	84.0	208	2.1	40	180	1.6	129	286	2.3
MAR. - OCT. - 1986	166	537	1.0	180	931	-	208	1302	1.6	180	630	1.9	286	1317	1.7

Sources: Kreiberg 1987a; Kreiberg 1987b.

However, as previously described, potential locations in southeast Alaska will likely have winter temperatures lower than those experienced in British Columbia (i.e., less than 5°C). Food conversion rates under these conditions will be slightly poorer than for comparably sized fish grown at higher temperatures. Brett (1979) suggests that conversion efficiencies at relatively low temperatures (1-5°C) are 50% of the maximum efficiencies which, as discussed above, occur at higher temperatures (e.g., between 10°C and 20°C). Therefore, for lower mean winter temperatures (3-5°C) that might occur in Alaska growout waters, slightly poorer conversions can be assumed compared to fish grown in British Columbia.

The feed conversions obtained for dry feeds at British Columbia sites were mainly under conditions of moderate salinity (Exhibit 3.6). As previously discussed, similar conditions can be expected in areas of southeastern Alaska, particularly along the mainland side. However, along the western side, salinities could, on average, be higher. The feed conversion efficiency of dry feeds could be reduced at high salinities (greater than 25‰) given higher energy requirements for osmoregulatory functions (Shaw *et al.*, 1975; Brett, 1979).

EXHIBIT 3.6: RANGE OF MEAN MONTHLY SALINITIES RECORDED AT FIVE CHINOOK SALMON CULTURE SITES IN BRITISH COLUMBIA; JULY 1985 - DECEMBER 1986.

LOCATION	MEAN MONTHLY SALINITY RANGE
1	24.8 - 29.9
2	21.6 - 27.7
3	19.5 - 26.4
4	19.1 - 32.0
5	19.9 - 25.1

Sources: Kreiberg 1987a; Kreiberg 1987b.

Probable feed conversions for dry feeds utilized in southeastern Alaska for the two temperature regimes described in Section 3.1 are shown in Exhibit 3.4. These feed conversions have been adjusted to reflect a decrease in feed conversion efficiency as the fish increase in size, and decreases that might occur at seasonally lower temperatures.

Near surface salinities (4 m depth) at the Little Port Walter Research facility ranged from 26.8 to 32.6‰; these are similar to but, in general, slightly higher than the salinities occurring at sites in B.C. (Exhibit 3.6). Experiments at Little Port Walter suggest that fish grow at similar rates using a dry pellet (Icicle Seafoods, Seward) and a semi-moist diet (Biodiet). Semi-moist and moist diets are preferred by some growers when salinities are high because they produce less physiological demand on the fish for osmoregulatory functions (Brett and Groves, 1979), compared to dry diets. However, dry diets are often preferred over moister diets, particularly in remote locations, because they are less expensive to transport and have longer storage times.

Summary

The area around Ketchikan is probably the best area for development of pen rearing of salmon in Alaska because of warmer summer and winter temperatures. Chinook could be expected to reach a harvestable size of two kilograms during the second winter in saltwater. However, the Ketchikan area would have lower growth rates and higher conversion rates

than in most areas of British Columbia where salmon farming occurs because of seasonally lower water temperatures.

We will assume that the growth of chinook in this area would approximate that of the warm winter/warm summer condition shown in Exhibit 3.4. In other words, a profile of a salmon farm can now be developed to allow comparison to costs in other supply regions. Costs for major inputs such as smolts, feed and labour will be estimated for this area.

REFERENCES

1. National Marine Fisheries Service, unpublished.
Results of initial studies on the feasibility of rearing chinook salmon to marketable size in seapens at Osprey Bay, Southeastern Alaska. Draft. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Laboratory, Auke Bay, Alaska.
2. Horner, R.A., L.S. Dick and W.E. Shiels, 1973.
Phytoplankton studies. (IN): D.W. Hood, W.E. Shiels and E.J. Kelley. (EDS): Environmental Studies of Port Valdez. University of Alaska, Institute of Marine Science, Occasional Publication No. 3, Alaska Sea Grant Program. Sea Grant Report 73-1, pp. 283-294.
3. U.S. Department of the Interior. 1984.
Final environmental impact statement. Volume I. Proposed Gulf of Alaska/Cook Inlet Lease Sale 88. Prepared by Minerals Management Service, Alaska Outer Continental Shelf Region, Anchorage, Alaska.
4. Gaines, G., and F. Taylor. 1986.
A mariculturist's guide to potentially harmful marine phytoplankton of the Pacific coast of North America. B.C. Ministry of Environment, Fisheries Branch, Marine Resources Section. Information Report No. 10, 55p.
5. Brett, R.
Formerly Senior Scientist, Pacific Geological Station, Nanaimo, British Columbia, pers. comm.
6. Hansen, J.A. (EDS). 1987.
FRED 1986. Annual report to the Alaska State Legislature. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development, Juneau, Alaska, 99p.
7. Bruce, H., D. McLeain and B. Wing. 1977.
Annual physical and chemical oceanographic cycles of Auke Bay, Southeastern Alaska. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Seattle, Washington. NOAA Technical Report NMFS SSRF-0712. 11p.
8. Jones, J. 1978.
Southeastern Alaska sea surface temperatures, 1964-74. U.S. Department of Commerce, National Marine Fisheries Service, Seattle, Washington. Northwest and Alaska Fisheries Center Processed Report.

9. Pickard, G. 1967.
Some oceanographic characteristics of the larger inlets of Southeast Alaska. Journal of the Fisheries Research Board of Canada. 24(7); 1475-1506.
10. Pacific Biological Station, unpublished, File data on growth rates. Canada Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, B.C.
11. Colonell, J. 1980
Physical oceanography. (IN): Port Valdez, Alaska: Environmental Studies, 1976-79. University of Alaska, Institute of Marine Science. Fairbanks, Alaska. pp. 11-35.
12. Xiong, Q., and T. Royer. 1984.
Coastal temperature and salinity in the northern Gulf of Alaska, 1970-1983. Journal of Geophysical Research (C5): 8061-8068.
13. Shaw, H., R. Saunders, H. Hall and E. Henderson. 1975.
Effect of dietary sodium chloride on growth of Atlantic salmon (Salmo salar). J. Fish. Res. Board. Can. 32:1813-1819
14. Brett, J., W. Clarke and J. Shelbourne. 1982.
Experiments on thermal requirements for growth and food conversion efficiency of juvenile chinook salmon Oncorhynchus tshawytscha. Canada Department of Fisheries and Oceans, Fisheries Research Branch, Pacific Biological Station, Nanaimo, B.C. Canadian Technical Report of Fish and Aquatic Science no. 1127. 29 p.
15. Kreiberg, H. 1987a.
Status report of the chinook broodstock strain comparison project No. 1 January 1987. Canada Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, B.C.
16. Kreiberg, H. 1987b.
Status report of the chinook broodstock strain comparison project No. 2 September 1987. Canada Department of Fisheries and Oceans, Pacific Geological Station, Nanaimo, B.C.
17. LaBelle, J., J. Wise, R. Voelker, R. Schulze, and G. Wohl. 1983. Alaska marine ice atlas. Arctic Environmental Information and Data Center, University of Alaska, Anchorage, Alaska. 302 p.
18. Brower, W., H. Diaz, A. Prectel, H. Searby and J. Wise, 1977.
Climatic atlas of the outer continental shelf waters and coastal regions of Alaska. Volume 1.

Gulf of Alaska. U.S. Department of Commerce,
National Oceanic and Atmospheric Administration,
Alaska Outer Continental Shelf Environmental
Assessment Program. Final Report -- Research Unit
No. 347.

19. Thrower, F.
Fisheries Research Biologist, National Marine
Fisheries Service, Auke Bay Laboratory, Alaska,
pers. comm.
20. Kreiberg, H.
Research Biologist, Pacific Biological Station,
Nanaimo, British Columbia, pers. comm.
21. Muench, R. and D. Nebert, 1973.
Physical Oceanography In D.H. Wood, W.E. Shiels and
E.J. Kelley (Eds): Environmental Studies of Port
Valdez. University of Alaska, Institute of Marine
Science, Occasional Publication No. 3, Alaska Sea
Grant Program. Sea Grant Report 73-1, pp. 283-294.
22. Brett, J.R., 1979.
Environmental Factors and Growth. In W.S. Hoar,
D.S. Randall, and J.R. Brett (Eds): Fish
Physiology, Volume VIII. Bioenergetics and Growth,
Academic Press. Toronto. pp. 599-675.
23. Brett, J.R., and T.D. Groves. 1979.
Physiological Energetics. In W.S. Hoar, D.J.
Randall and J.R. Brett (Eds): Fish Physiology,
Volume VIII. Bioenergetics and Growth, Academic
Press. Toronto pp. 276-352.

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Legislature Grapples with Mariculture Issue

by Rodger Painter, AMA Executive Director

Mariculture legislation was beginning to take shape by late March, but lawmakers were deeply split on some key issues and it was very unclear what kind of compromise bill might emerge by adjournment.

While the pros and cons of salmon farming had dominated the mariculture debate for the past two years, the focus of work by the Senate Resources Committee quickly shifted to land management and siting concerns. Environmental organizations joined with fishing organizations to push for very restrictive siting processes, while mariculture advocates and legislative supporters were fighting for more flexible approaches.

This shift in emphasis came after Governor Steve Cowper announced his opposition to the pen rearing of salmon "at this time," and amid growing indications the legislature is unlikely to approve the pen rearing of salmon this session.

One finfish compromise taking shape in the Senate would allow upland farming of all finfish, pen rearing of non-salmon species, and prohibit pen rearing for five years. However, some fishermen's groups quickly mounted stiff opposition, and it was unclear whether the proposal would remain on the table.

A significant change in the process has been the emergence of legislation with a restrictive approach to mariculture as the primary vehicle for legislative action. The focus of legislative discussion last year were two pro-mariculture bills (House Bill 108 by Rep. Johnny Ellis and Senate Bill 106 by Sen. Fred Zharoff), but by February it had become clear that the only proposal with any chance of moving was legislation authored by Senator Richard Eliason, the leading legislative critic of salmon farming.

Eliason's Senate Bill 482 made it clear that the powerful Sitka Republican also favored imposition of some tough siting standards for all forms of farming. Eliason, a lifelong salmon troller, said he favored a comprehensive approach to siting with a high degree of public involvement because coastal Alaskans are concerned about user conflicts with floating mariculture facilities.

Eliason had released two rewrites of SB 482 by late March and had produced a packet outlining four different options for land use

management options. The four ranged from a very restrictive option taken from a different bill proposed by Senator Lloyd Jones of Ketchikan to one written by the Alaska Mariculture Association (AMA).

The Jones' proposal was heavily favored by environmentalists and fishermen, and strongly opposed by shellfish farmers and mariculture groups, including AMA, the Alaskan Shellfish Growers Association, Kodiak Mariculture Association and the Kodiak Area Native Association (a key player in the Kodiak scallop project). Other groups such as the Resource Development Council, City of Unalaska, Alaska State Chamber of Commerce and Ounalashka Corporation joined in opposition.

Jones' proposal would create a system patterned after the state's oil and gas leasing program where sites available for mariculture development would be chosen by a call for nominations within mariculture districts. This list would then be whittled back by state agencies, a public hearing held, more cuts made, another public hearing held and the final offerings revealed. Applicants would be selected through a lottery process.

Mariculture supporters such as Senator Zharoff argued that the approach would favor larger companies and was too cumbersome for small scale farmers. Senator Arliss Sturgulewski pointed out that these requirements would be added to other existing public processes under the coastal management program.

Eliason wrote a slightly less cumbersome version of the Jones' approach that required only one public hearing, allowed farmers to propose individual sites (eliminating the lottery) and opened up a 60-day annual application period. The Department of Natural Resources (DNR), which manages state lands and tidelands and would be responsible for administering any land use management program, said it was developing an approach similar to Eliason's, but it did not favor putting the program in statute.

A third option was the approach taken in one of Eliason's bills which would require extensive public notice and a public hearing on each individual permit, but eliminated the area-wide approach to permit issuance. AMA's offered a similar version, except it would require a public hearing only when DNR determines a significant land use conflict might occur. A DNR spokesperson said the most favorable statutory approach was AMA's, although the department intends to follow a more comprehensive approach in implementing the policy.

After considerable debate, the Senate Resources Committee appeared to be poised to adopt that approach to site selection, but final agreement on a compromise bill was proving hard to reach. The committee was deeply split and it was difficult to predict at the time of this writing (3/28/88) what kind of bill would be reported out of the committee.

Particularly clouded was the finfish issue. Eliason's original bill would have banned the farming of all finfish in saltwater. Fishermen and environmentalists were pushing hard for this approach, while fish farming advocates were trying to narrow the restrictions to a one-year moratorium on the pen rearing of salmon.

Senator Sturgulewski was offering this proposal, along with language ordering state agencies to conduct several studies, and appointment of a citizen's task force to examine biological, land use, environmental and socio-economic issues raised during the debate.

Eliason later came out with a draft that put a five-year sunset clause on a ban on the pen rearing of salmon, allowed saltwater to be pumped to all upland finfish farms, sanctioned the pen rearing of non-salmon species of finfish and prohibited the saltwater rearing of Atlantic salmon. Eliason was working on another draft which backs away from upland saltwater salmon farms.

Text of Governor Cowper's Mariculture Statement

"Governor Cowper has not taken a position on any specific piece of legislation. However, the governor has determined that he does not support legislation authorizing salmon farming in saltwater at this time.

"The governor is strongly supportive of legislation which serves to clarify the legal status of mariculture and which opens the door for new economic initiatives through shellfish and sea vegetable farming.

"The governor believes that legislation must rely on existing agency roles and should enhance or supplement existing agency authorities to accommodate this emerging industry. For example, legislation should include appropriate measures to provide adequate levels of disease and genetics controls, inspection requirements, product quality wholesomeness, and resolve user conflicts for use of our tidelands.

"Generally, SB 482 fits many of these criteria. However, the respective agencies will be working with you (Senate Resources Committee) to resolve any technical issues."

A Call to Action for Mariculture Advocate

by Paul Fuhs, AMA President

If you believe that mariculture can play a role in Alaska's economic future, the legislature's current debate should be of great interest to you. The door would be slammed shut on Alaska's great potential in mariculture under pending legislation, and some environmentalists and fishermen have issued a call for a freeze on all mariculture permits.

Don't be lulled by the thought that a legislature so interested in economic development surely wouldn't dismiss the obvious potential of mariculture to diversify our economic base. The potential passage of anti-mariculture legislation is a very real threat, and not even existing farmers can escape the impacts.

In fact, I believe that the handful of farmers who have bucked the odds and established economically marginal shellfish farms are in danger of being pushed over the edge by some of the proposals being made.

Fishermen and environmentalists pushing anti-mariculture legislation have very effectively organized a strong grassroots effort pushing for restrictive tidelands management policies, significant increases in tidelands rentals, cumulative impact restrictions, and a cumbersome permitting process. Not to mention the permanent ban sought by many on all saltwater finfish farming.

AMA's arguments in favor of mariculture have been very

persuasive, but, frankly, we have lost the public involvement battle. While making the rounds in the Capitol Building, AMA Executive Director Rodger Painter and I have been greeted far too many times by legislators wondering when they were going to get some mail in favor of mariculture to offset the deluge of letters generated by fishermen.

We have gained important endorsements of mariculture development from the Resource Development Council, Southeast Conference, Anchorage Chamber of Commerce, Municipality of Anchorage, Alaska State Chamber of Commerce, RuralCAP, Kodiak Area Native Association, Southwest Municipal Conference, City of Unalaska and others. But, group endorsements are not nearly as effective as messages from constituents who voice deep concern about an issue.

This newsletter has detailed the legislative battle. The future of mariculture in Alaska is being decided, and lawmakers are mostly hearing that Alaskans want to stop a proliferation of aquatic farms along our coastline.

If you are a mariculture supporter, the legislature needs to hear from you. Write or call Gov. Cowper and legislators as soon as possible. AMA's ability to fashion acceptable legislation hinges on public support for mariculture.

Copies of Senate Bill 482 can be obtained from legislative information offices in many communities, or by contacting your legislator or AMA. The long-term future of mariculture in Alaska is being decided now, and your direct involvement will never be more important.

State Releases Salmon Farming Cost Analysis

A study funded by the State of Alaska concludes that Alaska farmed salmon would be competitive from a cost of production standpoint with most producing regions, but cautions British Columbia farmers have distinct advantages in most markets.

While Alaska farmers should not face problems with obtaining broodstock in Southeast and Southcentral, the study said fish feed would have to be purchased from out-of-state producers. The consultants also said the most attractive areas for development of salmon farms appear to be near Juneau, Ketchikan and Petersburg, the western side of Baranof Island near Sitka, and Southcentral areas near Kodiak, Homer, Seward, Cordova, Valdez and Whittier.

In a letter commenting on the report, AMA Executive Director Rodger Painter said the cost of production estimates appear to be a "good representation of anticipated costs," but the report failed to include lower cost feed options available. Painter said utilization of lower cost feed shipped from Seattle would lower operating costs significantly and improve Alaska's competitive position.

Painter also criticized the report for making "sweeping conclusions" about the effects of Alaska's cooler water temperatures and failing to consider two of the state's best potential growing areas--Prince of Wales Island and the Aleutian chain.

The report was prepared by the DPA Group, a Vancouver, B.C. consulting firm with solid aquaculture experience, as part of an effort to examine economic issues connected with salmon farming. The report estimated Alaska's cost of production for a pound of chinook

salmon at \$2.40 per pound, compared to \$1.67 for Chilean cohos, \$1.70 per pound for B.C. chinooks, \$2.55 per pound for Norwegian Atlantics, \$2.85 per pound for Scottish Atlantics, and \$3.03 per pound for Japanese cohos.

When delivery costs are included, Alaska would be competitive in selected major markets, according to the consultants:

Los Angeles--B.C. \$2.06, Chile \$2.63, Alaska \$2.77, Norway \$3.80, and Scotland \$4.17.

New York--B.C. \$2.44, Chile \$2.63, Alaska \$3.18, Norway \$3.46, and Scotland \$3.83.

Tokyo--B.C. \$2.89, Japan \$3.21, Alaska \$3.36, Chile \$3.85, Norway \$4.25, and Scotland \$4.62.

"Alaska is competitive from a cost standpoint in all markets," the consultants concluded. "However, costs at an industry level are only well known for Norway. As a result, the cost comparisons should be viewed with caution. Alaska would be selling farmed salmon in smaller sizes than Norway, Scotland and British Columbia and would compete more directly with the Chile. B.C. and Chile have cost advantages over Alaska in both Los Angeles and New York.

"Alaska would also likely have a short window period in which to sell. This would also likely result in more direct competition with the Chileans.

"Landed costs in major markets are sensitive to exchange rates. Fluctuating exchange rates could make Alaskan farmed salmon more or less competitive in all markets. However, the U.S. and Canadian currencies are closely linked and generally shift from each other only slowly. As a result, British Columbia would likely have cost advantages over Alaska in all major markets."

In a letter commenting on the report, Painter his research shows there are significantly less expensive feed options available than the assumption made by DPA. Painter said utilization of the most commonly used feed in B.C. would lower the feed costs for a 400-ton farm by about 31 percent.

"This kind of analysis should have been included in the report, as it makes a significant difference in outlooks on profitability and competitiveness of Alaska producers," Painter said.

His letter also was critical at the lack of mention of two major areas--Prince of Wales Island and the Aleutian Islands--which he said may be the two most desirable locations in Alaska for salmon farms. Painter also said that some information suggests that Alaska farms could experience improved mortality rates over most B.C.'s primary growing regions, offsetting the advantages of faster growth.

1988 Oyster Seed Prices Set by Wescott

Wescott Bay Sea Farms, one of three hatchery operations certified to sell oyster spat in Alaska, has released a notice of 1988 prices that reflect a jump in prices and improved availability of larger seed.

Wescott's 1988 prices for orders of less than 500,000 are: 3-5

mm, \$9 per thousand; 5-8 mm, \$11 per thousand; and 9-12 mm, \$12 per thousand. In 1987, Wescott set its prices at \$7 for 3-5 mm, and \$10 for 5-8 mm.

The quotes are for clutchless Pacific oyster seed for the gourmet half shell trade. These are the only oysters certified for importation into Alaska. Orders for more than 500,000 seed oysters receive discounts.

The company also has oyster and scallop culturing cages and other mariculture equipment available. Contact: Wescott Bay Sea Farms, 4071 Wescott Drive, Friday Harbor, WA 98250. (206) 378-2489.

B.C. Salmon Farmers Provide Valuable Insights for Alaskans

by Rodger Painter, AMA Executive Director

Opponents of salmon farming frequently suggest that Alaska should watch British Columbia closely for 10 to 20 years before deciding to take a leap into the pen rearing of salmon.

While this proposal obviously is designed to ensure that salmon farming never occurs in Alaska, there is a great deal of merit to the suggestion that Alaskans should look closely at B.C. before getting involved in salmon farming. This is particularly true for anyone considering investing in a salmon farm.

Opportunity--What anyone examining B.C.'s salmon farming industry quickly gathers is that there is tremendous opportunity available for Alaska. The B.C. salmon farming industry continues to experience a growth rate nothing short of phenomenal.

The provincial government estimates the number of operational salmon farms increased from 70 in 1986 to 113 in 1987. The on-line production capacity increased from 3,700 to 17,000 tons per year, while the hatchery capacity doubled to 65 million eggs.

Robert Nellis, executive director of the B.C. Salmon Farmers Association, predicts about 4,000 tons of fish will be sold during the 1987-88 selling season ending in May. This is up from 800 to 1,000 tons of sales the previous year. Industry analysts project B.C. sales at 20,000 tons by 1990.

Marketing/Quality--Farmers haven't been lulled by this early success, and are actively working to secure B.C.'s competitive position as worldwide farmed salmon production climbs. Nellis said his association collected about \$500,000 in membership dues this year, and pointed out that most of this money was taken from investment capital, indicating farmers place a high degree of importance on a cooperative approach. BCSFA hopes to pull in another \$500,000 in government grants for a variety of studies and programs.

Although farmers are having little problem selling all their production, Nellis said, most are concerned about the potential of glutted markets in the 1990s.

"Today, we don't have a problem," Nellis said. "Anyone can sell whatever they produce, regardless of quality, for a damn good price. But, we need to start working on programs for when the supply and demand situation changes."

The first step was to conduct a thorough study of U.S. fresh salmon markets, and to assess the strengths and weaknesses B.C. farmers have in the marketplace. This study was completed last year

by marketing experts who have since been hired by Alaska to conduct some economic studies on Alaska salmon farming.

BCSFA now is putting together an ambitious marketing and quality program based on that report. Nellis said the association is spending \$400,000 this year on quality and marketing, with the establishment of voluntary industry quality guidelines as the first objective. BCSFA will hire its own quality expert to inspect and monitor farming and processing operations.

The association also recently launched a generic advertising campaign stressing B.C. "super natural" culturing conditions, and capitalizing on the area's reputation for producing high quality salmon.

Early Maturity--One of the biggest problems faced by many B.C. farmers during the early growth of the industry is a high rate of "jacking" or the incidence of male salmon experiencing early sexual maturation. Work at Alaska's experimental salmon farm at Baranof Island suggests that Alaska will be faced with very similar "jacking" problems in both chinook and coho stocks.

The Canadians have largely solved the problem by neutering the fish with chemicals (mostly cohos) or producing all female brood (primarily chinook) through hormonal or hot water shock treatment. Farmers say the neutered coho have not performed very well, but most appear to be pleased with the all-female chinook stocks. In fact, all female chinook stocks appear to be the species of choice among farmers.

Broodstock Development--One of the most critical challenges of a new salmon farming industry is the development of a domesticated broodstock. Experienced salmon farmers like John Spence, president of Hardy Sea Farms, stress that development of domesticated brood will improve growth rates, feed conversions and mortalities.

Spence said that through selective breeding B.C. salmon farmers should be able to lower mortality rates from 30-40 percent of smolts raised from wild eggs to 7 percent with third generation smolts. "B.C. farmers will see substantial improvements with second and third generation smolts."

B.C. farmers placed the province's initial second generation chinook smolts into the water in 1987, and improvements already are being seen, according to Nellis.

Both men stressed that competition between private hatcheries is a key to a successful broodstock program, and warned against letting government take the lead. Farmers already have seen the results of stiff competition among private hatcheries where the emphasis has shifted from simply obtaining sufficient numbers of smolts to the quality of the broodstock.

Densities/Pen Size--One of the most notable differences between B.C. and the European salmon farming industries is culturing densities. B.C. salmon farmers utilize significantly lower densities than their European counterparts, because of differences between Pacific and Atlantic salmon, and the Norwegian experience with disease.

The B.C. industry-wide average for chinooks is about 6-7 kilograms per cubic meter, compared to a Norwegian average of 20-40 kilograms per cubic meter. Many B.C. farmers believe it is desirable to achieve even lower densities and the trends appear to be downward.

Tom May, president of Royal Pacific Sea Farms and former BCSFA president, said he believes optimum growing densities may be as low as 3 kg./cu. meter. May said the additional space in the net pens lowers mortality rates because the fish are less stressed and results in improved growth.

May also is an advocate of large net pens and Royal Pacific is experimenting with some 130 foot square net pens. The larger pens provide more room for the fish to swim around, and May believes the result will be enhanced growth.

A bonus of using larger pens is that the cost is significantly lower. For instance, Dick Howes, president of Aquasteel which is B.C.'s leading net pen manufacturer, said a 100-foot square pen costs about \$25,000, while a 50-foot square pen costs about \$15,000. Yet, Howes points out, the 100-foot pen has four times the capacity of the smaller version.

Some farmers warn that very low densities in very large pens might not achieve the desired result because the fish would end up being spooky.

Feed--One of the most critical decisions a farmer will make is the selection of feed. Feed accounts for about half of the operating expenses of most salmon farms, but the quality of feed also will affect growth rates, feed conversions and mortalities. Consequently, lower quality feed may lower operational costs, but losses to disease and reduced growth and feed conversions may more than offset the savings.

Moore-Clark, one of the major fish feed manufacturers on the West Coast, offers two basic salmon feeds: "new age" dry feed, and extruded. The extruded is a newer, "high tech" feed offering higher oil content, proteins, omega-three fatty acids, and other advantages over the new age feed, but it also costs about 14 cents per pound more.

This price gap could make a 37 percent difference in the feed costs of a 400 ton farm.

Like many experienced farmers, Spence stressed the importance of securing the highest quality feed possible, particularly when first getting into the business. Spence said one of the most important things a new farmer can do is to institute a quality control program for feed. He said it is important for the farmer to conduct his or her own quality program separate from the feed manufacturer.

NEXT MONTH: Siting strategies for salmon farms and an examination of the marketing outlook for farmed salmon.

The Alaska Mariculture Report is a monthly newsletter published by the Alaska Mariculture Association. We encourage contributions. AMA members receive the publication at no cost. Annual subscriptions are available to non-members for \$20 domestic or Canada, or \$25 foreign. For more information, contact: Alaska Mariculture Association, 130 Seward St., Suite 201, Juneau, Alaska 99801. (907) 463-3600.



Science
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Council Statement

Aquaculture: An Opportunity for Canadians

A Statement by the Science Council of Canada
on the Role of Aquaculture in Canadian Fisheries



March 1985

Contents

Preface	7
Chapter 1. The Significance of Aquaculture	9
International Involvement in Aquaculture	9
The Market for Canadian Aquaculture	10
Aquaculture and Fishery Management	10
Aquaculture and the Sport Fisheries	13
Canadian Commitment to Aquaculture	13
Chapter 2. The Viability of Canadian Aquaculture	14
Sites and Leasing Policy	14
Commercial Fishing Interests	14
Special Native Interests	15
Salmonid Enhancement and Private-Sector Ranching	15
Seed Stocks	16
Feed	17
Technology	17
Capital	18
Markets and Quality Assurance	20
The Role of Producer Organizations	20
Infrastructural Needs	21
Chapter 3. Agenda for Action	23
Glossary	25
Bibliography	27

Preface

In many countries commercial aquaculture* is creating profits, new wealth, and new employment opportunities. Yet in Canada it is still an undeveloped industry. Canada has been slow to apply the scientific knowledge available and to use new technologies of cultivation for this renewable resource.

The Science Council of Canada has identified aquaculture as an emerging area of science and technology offering new opportunities to Canadians to maximize the economic and social benefits of the natural resource industry. In July 1983 the Science Council, with the Department of Fisheries and Oceans, co-sponsored the first National Aquaculture Conference. The private sector, the research community, and different levels of government were asked to assess the potential of aquaculture in Canada. The final report from the conference participants concluded that:

For Canada [commercial aquaculture] means an opportunity to substantially increase exports, create new jobs, provide supplemental employment and income opportunities within the traditional commercial fishery, and to expand support industries that provide equipment, supplies and services. Furthermore, aquaculture has an important role to play in enhancing stocks of fish for the recreational and commercial fisheries. Canada's abundant resource base, both fresh and salt water, is more than adequate to support an aquaculture industry of major dimensions.

The conference strongly urged the government of Canada to designate aquaculture as a high-priority

opportunity for development and, in consultation with provincial governments and the private sector, to prepare a National Aquaculture Policy and Development Plan.

In response, the Science Council created an Industry Task Force on Aquaculture. In receiving their final report, Aquaculture: A Development Plan for Canada, the members of the Science Council recognized the significance of this rapidly developing, science- and technology-intensive industry to the need to restructure Canadian fisheries. This statement is based on the final report of the Industry Task Force, research contributions from private sector consultants, and consultations with representatives of the commercial fishing industry, the aquaculture industry, Native groups, and government and university departments. The Science Council believes that Canada's aquatic natural resources can benefit from the development of new technologies and methods that will increase production of commercially attractive marine and freshwater plants and animals by aquacultural methods without exerting further pressures on wild stocks.

* This and other specialized terms are defined in the glossary on pages 25 and 26.

Chapter 1

The Significance of Aquaculture

Aquaculture is expected to be one of the agri-business growth industries of the 1980s. This knowledge-intensive industry can be defined as the cultivation of aquatic organisms. It may involve careful control (intensive aquaculture) or minimal management (extensive aquaculture) of the organism's environment to increase survival and improve production. In the past, because of the abundance of wild fish, hunting and gathering met the needs of the market. Only in this century, when increases in population placed greater demands on wild stocks, has scientific understanding of aquatic species permitted the artificial cultivation of fish, shellfish, crustaceans, and seaweeds on a commercial basis. In the last two decades, the gap between demand and supply has prompted the application of farming techniques and new technologies to the cultivation of a wide range of aquatic species.

The application of science and technology to our natural resources can create new wealth and employment, especially in remote communities. Commercial aquaculture draws on a variety of technologies ranging from the development of pelletized feeds and new vaccines to the use of offshore technology in the design of marine enclosures and sea pens and automated feeding, harvesting, and processing techniques. Its advantages over conventional fish-catching methods include

- control of the environment for the organism;
- management of production and quality;
- efficient utilization of water for production;
- low energy costs;
- commercial profitability.

International Involvement in Aquaculture

Aquaculture is already established as a profitable industry in many countries. In the last decade, aquaculture production increased so rapidly that it already accounts for more than 10 per cent of the world's total harvest of fishery products. Leading aquaculture producers are China (more than 2 million tonnes or 25 per cent of its seafood production) and Japan (1 million tonnes or 10 per cent of its seafood production). In the developing countries, warm-water species such as tilapia show great promise as a source of inexpensively produced protein.

Aquaculture production has also been increasing rapidly in cool-water areas. Today, in European fish markets, all freshwater trout, most fresh salmon, mussels, oysters, and some turbot, eels, and freshwater crayfish are products of aquaculture. In North America most catfish, freshwater trout, crayfish, mussels, and oysters are produced by aquaculture. Increasing quantities of farmed shrimp, steelhead trout, abalone, clams, and salmon are also entering fresh fish markets.

The most dramatic example of recent aquacultural expansion of immediate significance to Canada is Atlantic salmon farming in Norway. In the late 1960s declining returns of wild salmon stocks were noted. At that time, Canadians and Europeans were experimenting with new techniques for artificially propagating salmon. In Norway, the application of scientific knowledge, some of it generated by Canadian scientists, allowed private-sector attempts at farming fish in the sea to succeed on a large scale. This led to the first commercial production of salmon. In 1973 Norwegian farmers

produced only 171 tonnes for sale. By 1983 Norway produced 22 703 metric tonnes of salmon and trout. Production in 1984 is projected to reach 25 000 tonnes with a first-hand sales value of more than U.S. \$100 million. The Norwegian salmon-farming industry now provides direct employment for more than 2000 people on more than 400 licensed and operating farms. When the employment from supporting trades such as feed supply, transport, and processing are added, the employment figure is at least 4000. The Norwegian government information service anticipates that by the year 2000 their aquaculture industry will generate goods worth U.S. \$3 billion and will employ some 50 000 people.

Smaller but similar salmon-farming industries are expanding with equal rapidity along the coasts of other North Atlantic nations such as Scotland, Ireland, Iceland, and the Faroe Islands. The prospects for the Atlantic salmon-farming industry are such that by the early 1990s, European production is expected to exceed 50 000 tonnes. This is about equal to the present total Canadian catch of Pacific salmon (see Table 1). In New Zealand and along the coast of Chile, farming and ranching of coho and chinook salmon are also developing. All these enterprises are independent, private-sector investments that reflect an entrepreneurial confidence in aquaculture.

Production from European salmon-farming industries has already had an impact on the traditional market outlets for frozen and processed Canadian salmon in Europe. What is more disturbing is the recent penetration of air-freighted fresh-farmed salmon from Europe into North American and Japanese markets. Norwegian air freight exports to North America started in 1981; by 1983 they exceeded 4000 tonnes. Totals for 1984, although unavailable at the time of going to press,

are expected to have increased considerably. Indeed, Norwegian exports are limited only by the present constraints on air freight capacity between Northern Europe and the United States. This level of imports into North American markets is already more than three times the current wild harvest of Atlantic salmon in Canada (see Table 1).

The Market for Canadian Aquaculture

Developing a domestic Canadian aquaculture industry aimed at important export markets such as the United States, Europe, and Pacific Rim nations will help Canada maintain her position as the leading fish exporting nation. Whenever a species is brought into cultivation, the year-round availability of superior-quality fresh produce creates new market opportunities for both the farmed and wild products. This phenomenon is analogous to what happened in the poultry industry when reliable mass-production techniques for chickens, turkeys, and ducks were developed in the 1940s and 1950s. Techniques that allowed cost-effective mass production, continuity of supply, and the application of quality-control procedures led to a rapid expansion of markets. Today, aquaculture is becoming a similar sort of agri-business.

Those species of most importance to Canada and for which commercial aquacultural technology already exists include salmon, mussels, trout, and several species of oyster. Clams, scallops, other shellfish, turbot, and arctic char also have some potential.

Aquaculture and Fishery Management

At a time when the wild fisheries are experiencing difficulties, aquaculture is supplying an increasingly significant proportion of fish protein. Around the world, aquaculture is seen as a means of producing badly needed high-quality protein while employing the under-used skills and capacity of the traditional

Table 1: Nominal Catch and Landed Value of Main Categories of Fish in Canada and Those of Interest to Aquaculture Production
(Quantity (Q) In tonnes live weight and Value (V) In \$000)

Species	1982					
	Atlantic Coast		Pacific Coast		Canada	
	Q	V	Q	V	Q	V
Total Groundfish	820 327	291 139	54 353	27 999	874 680	319 138
Total Pelagic and Other Finfish	270 150	52 714	98 857	198 091	306 007	250 805
Salmon	1 536	6 068	65 715	165 088	67 251	171 156
Total Shellfish	170 155	237 755	7 575	9 986	177 730	247 741
Oysters	1 321	1 323	1 579	981	2 900	2 304
Total Sea Fisheries	1 197 632	569 174	160 785	240 081	1 358 417	829 255
Inland Fisheries					57 743	58 847
Grand Total Canada					1 416 160	888 102
1983						
Total Groundfish	764 248	275 115	62 710	36 453	826 958	311 568
Total Pelagic and Other Finfish	201 785	46 757	112 293	149 228	314 078	195 985
Salmon	1 210	4 797	70 630	104 000	71 842	108 797
Total Shellfish	141 991	294 662	7 797	12 206	149 788	306 868
Oysters	1 486	1 373	1 600	1 040	3 086	2 413
Total Sea Fisheries	1 108 024	621 243	182 800	202 190	1 290 824	823 438
Inland Fisheries					50 000	50 800
Grand Total Canada					1 340 824	874 238

Source: Canadian Fisheries Highlights 1983, Statistics and Analysis Division, Fisheries and Oceans Canada, 1984.

fishing industry. The profitability of aquaculture and its ability to contribute new employment and wealth to local economies is no longer questioned. There are many large-scale aquaculture development programs for coastal areas, most of them supported by international aid financing, that retrain fishing employees in aquaculture techniques for the production of tilapia, milkfish, sea bream, prawns, and many other species.

In the European Economic Community, for example, aquacultural initiatives are an integral part of fishery management policy and a mechanism for economic development in rural communities. In Norway aquaculture and the traditional fisheries are closely allied. Almost 50 per cent of the salmon farmers are former fishermen or traditional fishing industry employees. Extensive use is made by the salmon-farming industry of the technologies developed in support of the traditional fisheries. Recent Norwegian projections indicate that by 1985 sales of farmed salmon and sea-reared trout will exceed their sales of cod, traditionally the main export species, with exports valued at about U.S. \$135 million. Japanese aquacultural operations are now intertwined with those of the coastal fisheries and play an important economic role in their maintenance; the artificial harvest of several species now greatly exceeds the production of the natural stock.

The potential of aquaculture as a facet of fish production remains largely unrecognized in Canada. In maintaining its position as the number one fish-exporting nation in the world and in attempting to conserve wild stocks, Canada has established extensive programs of fishery management. These vary from catch quotas and other regulatory controls to quality-improvement and cost-reduction programs, stock enhancement, and

related research programs. Such programs constitute a large part of the total costs of managing Canadian fisheries. The integration of resource management policies with commercial aquaculture development would cut down on the use of public funds and may lead to beneficial technical spin-offs.

The classic problem confronting the traditional fisheries is the common property of the resource. As long as individuals do not own the rights to harvest a specific share of the wild fisheries, they will have no individual incentive to conserve it properly or harvest it efficiently. There is a well-documented and well-analyzed tendency toward excessive exploitation of the resource and excessive investment in the industry, as individuals attempt to increase their own share at the expense of others.

Fishery management policies are intended to address this fundamental economic problem. Harvesting quotas, the establishment of privately managed terminal or "pocket" fisheries, the authorization of privately financed enhancement "ranching" operations are all methods of overcoming the problems associated with common property ownership. Commercial aquaculture is a logical extension of these measures. With fixed-enclosure aquaculture, the common property problem in harvesting is eliminated, providing the institutional framework for the efficient production of fish products from privately owned or leased farms.

This is not to suggest that aquaculture can resolve all current fishery management problems, or substitute for commercial wild production. Properly managed wild fisheries can yield considerably lower-cost fish than intensive aquaculture. However, wild resources are harvested seasonally and cannot provide sufficient quantities of

top-quality fresh produce to year-round markets. Reducing the wild catch in order to increase escapements is probably the most cost-effective short-term means of increasing wild production -- certainly more so than constructing new public hatcheries. However, aquaculture can provide an efficient source of incremental fish production to meet the growing demand for fish products and to relieve increasing pressures on the wild resource.

Aquaculture and the Sport Fisheries

Some of the pioneering efforts in Canadian aquaculture involved the construction and operation of hatcheries for sport fisheries. At present some of the private trout hatcheries across Canada stock lakes for the inland sport fisheries; the salmon and steelhead trout sport fisheries are enhanced through the work of the Department of Fisheries and Oceans. These sport fisheries are extremely important to Canada. On the west coast alone, the direct income impact of resident tidal and nontidal angling in 1980 was estimated at between \$38 million and \$40 million, with direct employment in the range of 3500 to 4000 person-years.

An emerging aquaculture industry with efficient methods of producing juvenile fish has a role to play in supplying the needs of sport fisheries. Reducing commercial pressure on salmon stocks by farming these species would help to meet growing sport and Native food requirements without further depleting the wild resource.

There is no reason why the aquaculture industry should not develop alongside a flourishing sport fishery. As the sport fisheries develop, so will their need for suitable stocks of juvenile fish for stocking rivers and lakes. Commercial aquaculture can supply these future needs at lower cost than current government-run hatcheries can.

Canadian Commitment to Aquaculture

Aquaculture has an important part to play in the Canadian fisheries. However, to realize its benefits, a firm commitment from both federal and provincial governments is needed. Therefore,

1. The Science Council of Canada recommends that federal and provincial governments state clearly their intention to develop a commercial aquaculture industry in Canada. In consultation with industry, specified production targets for identified species should be set. Governments should take concerted action to ensure that aquaculture is made an attractive area for investment and create lead agencies, as outlined in the final report of the Industry Task Force, to coordinate the development strategy for this emerging science-based industry.

Chapter 2

The Viability of Canadian Aquaculture

Other countries, when faced with declines in their traditional fisheries caused by environmental problems or jurisdictional limitations, have turned to large-scale aquaculture development. A recent survey of salmon farms in Norway showed that they produce an average annual operating surplus equivalent to about Cdn \$30 000 per employee. A study by the Department of Fisheries and Oceans recently determined that the gross profit of Norwegian salmon farms was approximately 27 per cent of gross sales. There is every reason to believe that if an integrated industry is launched in Canada, similar profit levels could be achieved in less than a decade. Marketing studies done for salmon farming on both Canadian coasts conclude that even with the expanding production of farmed fish from other countries, Canada has sufficient market potential to support an aquaculture industry.

In order to establish a commercially viable aquaculture industry in this country, several essential components must be developed in concert.

Sites and Leasing Policy

The extensive coastline and abundant freshwater resources of Canada offer many possible sites for aquaculture, well within the acceptable temperature limits for the growth of commercially significant species. Indeed, the coasts of Canada could ultimately sustain a very large scale of production. Across Canada good sites for the cage, pond, and raceway cultivation of trout and other species abound. However, only a few have been developed even on an experimental scale.

Site availability will not limit the development of an aquaculture industry in Canada. However, the sites identified by the private sector must be opened up to commercial aquaculture development

without adversely affecting other users of coastal and shoreline areas. This requires the creation of appropriate leasing policies. Various ways of influencing the development of the industry through leasing policies might include:

- (a) the attachment of specific terms and conditions to aquaculture permits to limit ownership of the resource to resident individuals or companies;
- (b) the provision of special incentives, such as grants, access to low-interest loans, and technical services, to locally-owned operations;
- (c) the provision of similar special incentives to scattered small producers to enable them to organize into more efficient integrated cooperatives or large firms.

Clearly, aquaculture developments in rural areas can provide employment and income for the local residents. If leases can be reserved for these people (or for applicants who will ensure significant local participation) without compromising the economic performance of the operations, the developments would be doubly beneficial -- they would provide a return on investment as well as badly needed income and employment.

Commercial Fishing Interests

The negative effects of reducing the commercial fishing fleet capacity can be mitigated if new employment in aquaculture is created at the same time. Preferential access to aquaculture leases or special opportunities offered to those displaced from the wild fisheries through the buy-back programs could achieve this goal. Governments may wish to promote entry into aquaculture for anyone participating in the A-licence

(salmon fishing) buy-back program. This would also offer the side-benefit of new productive uses for existing excess fishing vessels. Since moving into aquaculture production requires new skills, training and extension courses must be organized.

Special Native Interests

For Native people, the issue of certain leasing policies affects not only economic development opportunities but also aboriginal land claims. Confrontation between Native people and private-sector entrepreneurial interests over aquaculture development must be avoided.

If leases are not allocated in an equitable way, Native people will undoubtedly argue that future land claims settlements may be compromised. This would not only be perceived as an injustice to Native groups, but might also result in the obstruction of aquaculture development with legal and political actions challenging the issuance of leases to non-Natives. Thus, in developing leasing policy, all levels of government should consult with Native groups prepared to enter into this new industry. The federal Department of Indian and Northern Affairs should ensure that Native interests are represented in all aspects of aquaculture policy and planning. Federal/provincial coordination in the development of leasing policies is also needed to ensure that matters of aboriginal and usufructuary rights within federal jurisdiction are not ignored by provincial leasing initiatives.

2. The Science Council of Canada recommends that both federal and provincial levels of governments work with the private sector and with representatives of Native groups to prepare enabling legislation to establish a legal framework for the conduct of

commercial aquaculture, to clarify or create the necessary rights, supply financial incentives, and regulate the industry as appropriate.

Salmonid Enhancement and Private-Sector Ranching

Salmonid enhancement programs for Pacific salmon evolved from efforts to conserve salmon stocks, increase returns to the west-coast fishery, and improve incomes, regional employment, and economic development. Enhancement of wild salmon stocks employs extensive aquaculture techniques to artificially propagate salmon eggs in hatcheries and release juvenile salmon (smolts) into the wild. Salmonid enhancement programs (SEPs) have considerable facilities, personnel skills, research capabilities, and some brood stocks. The aquaculture industry should have access to these resources from which they could draw assistance to accelerate the growth of commercial aquaculture. Research on pathological, nutritional, genetic, and physiological problems of salmonids relate to the needs of the aquaculture industry. The aquaculture of salmonids in sea pens offers many opportunities for research investigations that could assist the enhancement of wild stocks.

Commercial salmon ranching involves technology transfer of government hatchery research and practices into the private sector as a business. Elsewhere, economic incentives for salmon enhancement that are directly linked to harvest opportunities have encouraged the private sector to share more of the responsibilities and costs for enhancement, habitat protection, and harvest management. Although biological and social concerns must be considered, there are also strong arguments in support of Canada increasing the extent of private-sector involvement in both enhancement and private-sector ranching as an adjunct to commercial aquaculture. Proponents of commercial

salmon ranching argue that it would lead to more efficient management of the fishery and to greater economic benefits for those employed in it.

A key element in the cost of salmonid enhancement is the cost of rearing juvenile salmon. The improved, more efficient techniques used in the fish-farming industry, if applied to salmonid enhancement, could help reduce rearing costs. Contracting out more of this work to the private sector could also improve the efficiency of salmonid enhancement. This might include placing some existing SEP hatcheries under private-sector management and allowing them to reduce costs by the sale of surplus eggs, fry, and smolts to salmon farmers. SEPs could also contract out new commercial hatcheries to rear fry specifically for enhancement purposes.

Tests of commercial ocean-ranching ventures, involving both Pacific and Atlantic salmon and other species, are being carried out in other countries such as the United States, Iceland, Chile, and Scotland. To enhance the public fisheries, Alaska has encouraged the development of non-profit salmon hatcheries operated by fishing cooperatives and interested individuals. Along the Pacific coast (in California, Oregon, Washington State, and Alaska), both public and private sectors are involved in enhancement, but only in Oregon and California has this been permitted on a profit-making basis. It is still premature to evaluate the success of such ventures. However, Canada should not preclude private-sector experimentation and involvement in this interesting field. In particular, using surplus fry and smolt production for ranching operations alongside farming operations may work well in Canada.

3. The Science Council of Canada recommends that the Department of

Fisheries and Oceans develop policies integrating the needs of fish population enhancement with the needs of a commercial aquaculture industry. Private-sector management of enhancement programs should be permitted.

Seed Stocks

Supplies of hatchery-reared seed stock are an essential component of the industry. Mussel farmers and oyster farmers in Canada currently depend largely on the collection of wild seed. These seed collection areas must be protected from environmental degradation, commercial exploitation, and depletion of the brood stock to allow expansion of mussel and oyster production. As the oyster industry moves toward more intensive forms of cultivation and the volume of production increases, wild sources of seed (spat) will become inadequate to supply the industry. On the Pacific coast the oyster industry is already beginning to use hatchery-reared spat, and in Nova Scotia the developing industry of rearing European oysters depends exclusively on supplies of hatchery-reared seed.

Allied to seed stock availability is the need for genetic selection of suitable genotypes and for selective breeding programs. Their importance to aquaculture parallels the importance of selecting suitable strains in the poultry, pig, and cattle industries.

The supply of juvenile salmon (smolts) that have suitable genetic strains for rearing under farm conditions is an important limiting factor in the production of farmed salmon in Europe. Farmed salmon production in Canada cannot expand significantly until appropriate supplies of smolts are available from government hatcheries and a sufficient number of commercial smolt production facilities are established by the industry.

4. The Science Council of Canada recommends that Canadian governments at all levels cooperate closely with the industry to support the creation of private-sector hatcheries sufficient to supply the needs of a rapidly growing industry with superior strains of seed stock.

Feed

Shellfish cultivation usually uses the natural planktonic food in the water. Thus feed costs contribute little to the cost of production, except in the intensive hatchery production of oysters and other shellfish. However, finfish aquaculture requires the feeding of artificially formulated diets to fish enclosed in cages, tanks, ponds, or raceways. The cost of fish feed is critically important to the viability of the industry.

As in the production of feeds for poultry and other agricultural industries, feed production in fish farming involves the formulation of relatively low-cost protein, fat, and carbohydrate sources into nutritionally adequate packages. Canada is well endowed with supplies of the raw fish wastes that are used for such feed. At the moment, much of this raw product is exported rather than being upgraded by producing pellets in Canada.

Feed technology also requires scientific knowledge of the nutritional needs of fish species. Several groups of Canadian researchers already have substantial expertise in this area. To date, much of their research has been applied by feed-stock producers in other countries. Tapping these resources would lead to the development of a domestic fish-feed industry, replacing imported feed stocks. The fish-farming industry that can be supported on the west coast alone is expected to be at least as large as that of Norway where there are several fish-feed producers.

5. The Science Council of Canada recommends that the aquaculture industry develop commercial applications for Canadian raw fish wastes and sponsor research, particularly in fields such as fish nutrition and feed technology.

Technology

In order to establish an efficient, profitable industry, it is essential to reduce the costs of production. This can be done by introducing automated techniques and expanding commercial production using the most modern methods and technologies available. A great deal of the necessary commercial-scale production technology and know-how is already available. The techniques of commercial production and sea-farm management must be transferred to Canadian industry as rapidly as possible, to adapt them to Canadian conditions and to deploy them in expanding commercial ventures.

There are many ways of obtaining foreign technology and know-how. In the present context, the most relevant mechanisms are the negotiation of technology transfer agreements, attracting direct investment by companies with this know-how to Canada by joint ventures, special licensing arrangements, and technical exchange training programs.

Arrangements like these are essential to accelerate the development of Canadian aquaculture. First, they will inspire greater confidence in the growth of the industry and will attract sources of risk capital. Second, these arrangements will help Canadian companies to earn profits more rapidly. Third, they will accelerate the rate at which production increases, thereby enabling Canadian production to become known and established in world markets in the next decade. Therefore, Canadians must acquaint themselves with overseas firms from which they could

buy technology, or to which they could sell their produce.

6. The Science Council of Canada recommends that industry, with the support of the relevant government agencies and centres of aquaculture research and development, seize opportunities for technology transfer and develop new markets for species under commercial production in Canada.

This process of adapting foreign technology to the Canadian situation can draw on existing scientific capability in Canada. If some of the substantial research capability in Canada were applied to the problems inherent in commercial aquaculture, considerable advances in commercial production could be achieved in a relatively short time. The research community has an important role to play together with industry in the three distinct facets of technology development and transfer through:

- a) the transfer of already-established commercial technologies and know-how to Canada;
- b) research and development programs to create the indigenous technologies that will allow commercial-scale aquaculture in Canada;
- c) the export of improved aquacultural technologies from Canada.

7. The Science Council of Canada recommends that governments direct their lead agencies for aquaculture to coordinate funding from all sources and, with the advice of the Regional Aquaculture Coordinating Committees recommended by the Industry Task Force, channel funds into development of the species identified as having the greatest commercial potential in each region.

Although it may be premature to discuss the export of aquacultural technologies from Canada before a commercial aquaculture industry has been established, the long term could bring significant spin-off benefits to other Canadian industries as well as constituting a component of Canadian aid to less developed nations. The International Development Research Centre and the Canadian International Development Agency are already involved in aquaculture assistance to less developed nations. The creation of an indigenous aquaculture industry in Canada could only strengthen these initiatives.

Capital

The success stories of aquaculture in other developed countries should encourage Canadian sources of capital to invest in this new area of opportunity. As the federal government's report, A New Direction for Canada: An Agenda for Economic Renewal, states:

If we are to be competitive, we must become effective in applying leading-edge technologies in producing goods and services. Economic success will stem not only from producing technology, but from using new technology in established industries.

The basis of a successful aquaculture industry will be a core of integrated, self-sufficient companies and cooperatives that use the most advanced technologies available. Operations like this are the mainstay of the industries established in Europe. These operations need several million dollars in investment and equivalent sums of working capital. When such enterprises are fully established, smaller grow-out operations can prosper. However, the front-end costs are high, there are inherent risks in cultivating living organisms, and a

relatively long-term investment is needed (a minimum of three years before there is a return on capital), therefore it may prove difficult to attract domestic capital.

To make the transition from pioneering efforts in aquaculture to a highly capitalized industry employing sophisticated technology, four likely sources of capital could be tapped:

1. Existing Canadian aquaculture enterprises could achieve the necessary rapid growth by entering into joint ventures with large firms that have capital to invest. These might include, for example, Canadian firms with an interest in fisheries, related resource-based firms, or the food industry. They could also include foreign firms that already have expertise in aquaculture. Entering into such joint ventures may turn current owner/managers of aquaculture enterprises into minor shareholders, or even managers of their firms.
2. Existing Canadian firms already involved in fisheries or in the resources sector may invest in aquaculture on their own. They will then need to buy the necessary expertise either from domestic or from foreign sources.
3. Governments could take minority-share status in aquaculture firms. This route has been successful in remote areas of the Highlands and Islands of Scotland as a way of enabling small producers to establish new enterprises.
4. Foreign firms with capital or expertise could be encouraged to establish "greenfield operations," i.e., new businesses involving specially constructed facilities.

Canada may ultimately have to depend on a judicious blend of foreign and domestic capital to develop this sector,

despite the tradition of giving preference to Canadian capital. In any case, Canadian firms must improve their operations, especially to attract capital and enhance their reputation as business partners. Before new investors will support this area of new technology, entrepreneurs must strengthen their managerial capabilities and incorporate the most modern techniques and technologies currently available.

8. The Science Council of Canada recommends that entrepreneurs in the aquaculture industry create the appropriate conditions to attract investment capital by:
 - a) participating in technical exchange agreements and adapting foreign and domestic best-practice technology;
 - b) examining ways of reducing risk to meet the standards set for aquaculture insurance;
 - c) raising the quality of their business planning.

Although investment money is available in Canada, most of it is put into more secure, better-understood areas of investment. Government policies are needed that will create a climate of certainty to elicit the necessary investment. At the moment, jurisdictional competition between levels of government and among different departments only adds to confusion and uncertainty. A clear signal would be sent to the investment community if the government announced the development of a commercial aquaculture industry with specified production targets for particular species as a provincial or even a national goal and launched a concerted effort to achieve this goal within the decade.

9. The Science Council of Canada recommends that federal and provincial ministries clarify their departmental mandates regarding

aquaculture and evaluate their programs with a view to enhancing their support for commercial aquaculture.

Governments must reorder their investment incentives to attract Canadian capital into promising new areas of knowledge-intensive development, such as aquaculture. Tax measures that ensure the eligibility of new capital for these emerging opportunities should be instituted. There are also sound economic reasons for direct government support to sectors such as aquaculture, that are relatively risky and require "patient" capital. The federal and provincial governments could identify the most appropriate mechanisms to enhance the development of these sectors. Given its proposed new proactive mandate, Investment Canada might help by attracting new foreign investment. Similarly, governments could provide the appropriate communication, transportation, and veterinary infrastructure to signal their support for the industry and the investment community.

10. The Science Council of Canada recommends that Investment Canada use its new proactive mandate to seek out sources of both domestic and foreign capital with a view to facilitating investments that will stimulate the development of Canadian aquaculture capabilities. It further recommends that External Affairs, through its science counsellor network, assist entrepreneurs to identify opportunities for international technical exchange agreements.

Markets and Quality Assurance

Marketing is a crucial part of a successful industry. Aquaculture in other countries expanded on the basis of

developing new markets and providing fresh produce to these markets "in the right place, at the right time, and at the right price." Good market potential in the United States, Europe, and the Pacific Rim countries exists for all the prime candidate species of Canadian aquaculture. To penetrate these markets, marketing strategies must be based on consistent supply and quality assurance. This requires an informed and disciplined approach to marketing and close cooperation among individual producers through their organizations and interaction with government regulatory agencies.

Indeed, it would greatly benefit the entire fishing industry if quality-assurance standards and marketing strategies developed in the context of aquacultural production were integrated with the standards and strategies that apply to the harvesting of wild stocks.

11. The Science Council of Canada recommends that the aquaculture industry create effective producer organizations to provide a forum for continuing consultations with government, to cooperate and share knowledge within the industry and enable producers to develop self-discipline concerning quality-assurance standards and market promotion.

The Role of Producer Organizations

Producer organizations are perhaps the most powerful force to influence the course of development of aquaculture. In the wild fisheries, fishing cooperatives and other industrial organizations have exerted powerful political and economic influence on the shape of the industry in the production, processing, and marketing sectors. Farmers' organizations have had a similar influence on the development of government policies and programs for agriculture.

In countries in which commercial aquaculture flourishes, producers' organizations with strong marketing interests are supported by a levy on farmers' sales or production totals. The European Economic Community offers incentives to newly created producers' associations, such as 80 per cent of their operating costs in their first year, declining gradually over five years.

Canadian aquaculture producers must work toward the development of a disciplined industry that uniformly upholds high standards of quality assurance and that can agree on the seasonal distribution of production to available markets. Strong producers' organizations can provide a coherent voice for the industry to all levels of government on the development of policy and can assist in communications and technology transfer within the industry. They must work to ensure the orderly development of the industry and to prevent destructive local competition among producers when they pool their resources to compete effectively on international markets.

However, at present, the embryonic industry does not have the resources or personnel to establish an effective organization to represent the national interests of aquaculture producers. The creation of national producer groups under the umbrella of the Aquaculture Association of Canada (formed in 1983 at the first National Aquaculture Conference) should be assisted at these early stages with government support. As the industry takes shape, such assistance should be phased out in favour of self-supporting industrial associations.

12. The Science Council of Canada recommends that governments extend assistance to the aquaculture industry for an initial five-year period to help create effective producer organizations.

Infrastructural Needs

The range of programs already in place to manage the wild fisheries is impressive. Many of the skills and resources in these programs could be applied to the development of commercial aquaculture. For example, expansion of the existing fish pathology capabilities in universities and in the federal Department of Fisheries and Oceans would provide an efficient veterinary and diagnostic service for fish farmers. Applying existing fisheries research capabilities could bring promising candidate species into commercial cultivation and initiate research on relevant diseases, nutritional problems, breeding programs, and other topics of economic significance to the industry.

An aquaculture industry will require a range of supporting services, including veterinary and diagnostic services, research and development work, quality-assurance requirements, and an advisory extension service to fish farmers (comparable to that in place for agriculture). These were outlined in more detail in the Industry Task Force report, Aquaculture: A Development Plan for Canada.

13. The Science Council of Canada recommends that the federal government work with provincial governments, in consultation with the industry, to establish appropriate services, particularly aquacultural veterinary and pathology services.

Furthermore, federal and provincial governments should cooperate to develop centres of excellence that would serve the needs of the aquaculture industry. Research and education facilities already exist in Nanaimo, Guelph, and Halifax, which could serve as the nuclei for such centres. Cooperative education programs, such as those developed at the University of Waterloo (involving several

months of practical on-site experience), and the curriculum of the University of Stirling's Institute of Aquaculture in Scotland should be considered as models for curriculum development.

14. The Science Council of Canada recommends that federal and provincial governments cooperate to develop centres of excellence to serve the needs of the aquaculture industry.

Local Community Economic Development, Job Creation, and the Public Involvement and Small Projects components of the Department of Fisheries and Oceans' Salmonid Enhancement Program has done much to interest Native people, young people, and local residents in the "hands-on" management of fish. However, technicians must be trained in the basics of commercial aquaculture and business management techniques. This can best be accomplished at the level of community colleges and technical schools in short basic learning programs augmented by extension courses (such as seminars on specific species or problems). Again, these training programs should be integrated with practical on-site experience; Scottish extension programs should be examined. Video-taped learning modules should also be prepared by Canadian colleges and universities in cooperation with universities and agencies abroad and distributed to fish farmers to show specific fish diseases or new technologies that could be adapted to Canadian fish farms. (This is already being done on a commercial basis in Norway.)

15. The Science Council of Canada recommends that federal and provincial governments support the development of commercial aquaculture with retraining programs, local employment programs, and community development projects.

Agenda for Action

Canadian aquaculture is on the threshold of commercial development. Although Canada is currently lagging behind other nations in developing this technology, it now has an opportunity to develop this industry very rapidly. During the next decade, it could create an indigenous Canadian aquaculture industry of at least the same capacity as Norwegian aquaculture. Canadians must quickly adopt, adapt, and develop the necessary techniques for a viable aquaculture industry before the window on market opportunities closes. One thing is clear. At both the level of governmental policy and industrial application, a great deal can be learned from other countries.

The recommendations for aquaculture are summarized below. They are grouped according to sector and listed in order of priority.

The Science Council of Canada recommends that federal and provincial governments:

- recognize commercial aquaculture as a high-priority opportunity for development (see recommendation 1);
- establish lead agencies to coordinate and encourage the development of this emerging science-based industry (recommendation 1);
- direct these lead agencies for aquaculture to coordinate funding from all sources and, with the advice of Regional Aquaculture Coordinating Committees, channel funds into development of the species identified as having the greatest commercial potential in each region (recommendation 7);
- cooperate closely with the industry to support the creation of private-sector hatcheries sufficient to supply the needs of a rapidly

growing industry with superior strains of seed stock (recommendation 4);

- extend assistance to the industry for an initial five-year period to assist in the creation of effective producer organizations to provide a forum for continuing consultations with government, to cooperate and share knowledge within the industry and to enable producers to develop self-discipline concerning quality assurance standards and market promotion (recommendation 12);
- work with the private sector and with representatives of Native groups to prepare enabling legislation to establish a legal framework for the conduct of commercial aquaculture, to clarify or create the necessary rights, supply financial incentives, and regulate the industry as appropriate (recommendation 2);
- support the development of commercial aquaculture with retraining programs, local employment programs, and community development projects (recommendation 15);
- cooperate to develop centres of excellence to serve the needs of the aquaculture industry (recommendation 14);
- clarify departmental mandates regarding aquaculture and evaluate programs with a view to enhancing support for aquaculture; in particular, Investment Canada should use its new proactive mandate to seek out sources of domestic and foreign capital with a view to facilitating investments that will stimulate the development of Canadian aquaculture capabilities; and External Affairs, through its science counsellor network, should assist entrepreneurs to identify opportunities for international technical exchange agreements (recommendations 9 and 10);

- develop policies integrating the needs of fish population enhancement with the needs of a commercial aquaculture industry (recommendation 3);
- establish appropriate services for the industry, particularly veterinary and pathology services, in consultation with the industry (recommendation 13).

The industry should:

- create effective producer organizations to provide a forum for continuing consultations with government, to cooperate and share knowledge within the industry and enable producers to develop self-discipline concerning quality assurance standards and market promotion (see recommendation 11);
- seize opportunities for technology transfer and develop new markets for species under commercial production in Canada (recommendation 6);
- create the appropriate conditions to attract investment capital by:
 - a) participating in technical exchange agreements and adapting foreign and domestic best-practice technology;
 - b) examining ways of reducing risk to meet the standards set for aquaculture insurance;
 - c) raising the quality of their business planning (recommendation 8);
- develop commercial applications for Canadian raw fish wastes and promote scientific research, particularly in fields such as fish nutrition and feed technology (recommendation 5).

SALMON CULTURE, FISH HEALTH AND THE ENVIRONMENT

By John Pitts, D.V.M.

Opponents of salmon farming in Washington State have claimed that wild populations of salmon will suffer from increased disease problems if salmon farming is allowed to proceed. Salmon aquaculture has prospered in Puget Sound for nearly 20 years in net-pens and for over a hundred years in state and federal hatchery programs. There has been no evidence of disease transmission to wild stocks because of these programs in Washington State. In addition, our neighbors to the north have been planting fish for over 100 years and there is no evidence that Canadian fish stocks have been adversely affected by diseases introduced from hatchery aquaculture (Hicks, pers.comm., 1988).

When fish biologists and pathologists have been asked to comment on this question, the answer has been consistent: Transmission of disease from farmed salmon to wild fish could happen, but it is very unlikely and has not been observed. More probable is the transmission of disease from wild fish to cultured fish (Kevin Amos, Washington State Department of Fisheries; Dr. Ralph Elston, Batelle NW; Dr. Lee Harrell, National Marine Fisheries Service; Dr. Brad Hicks, British Columbia Veterinary Service; Dr. Mike Kent, Batelle NW; Dr. Marsha Landbolt, University of Washington; Dr. Gary Wedemeyer, United States Fish and Wildlife Service; Dr. Jim Winton, United States Fish and Wildlife Service, pers.comm., 1988). The same response was given by scientists from Europe experienced in fish culture (Dr. Hans Achevors, University of Stockholm; Dr. Ron Roberts, Stirling University; Dr. Harald Rosenthal, Hamburg, West Germany). In no case has any evidence been presented to show that disease has moved from private sector aquaculture to the wild fishery (Needham, 1981; Neuman, 1986). As stated, the opposite is true, fish in private culture frequently become sick from communicable diseases when they are exposed to wild fish (Hicks & Ferguson, 1986; Hedick, et.al., 1986; Ostland, et.al., 1987). Although we must be aware of the interaction of disease in wild and cultured stocks it is much more likely that the private sector aquaculture will be adversely affected by diseases present in wild populations than vice versa.

The potential for any disease transmission, be it direct contact, air borne or water borne, is much greater when the organism is under stress. Experience has shown that a wide variety of bacterial, parasitic and other diseases become a problem only if fish are being held under environmental conditions unfavorable

for that particular species or strain. Such unfavorable conditions include crowding, temperature fluctuations, inadequate dissolved oxygen, excessive rough handling, sublethal levels of toxic materials, etc. (Wedemeyer, et. al., 1976). It is not in the best interests of the fish or fish farmer to crowd his farm or he may suffer crop losses. The farm itself must be located in an area of good oxygen supply and good flushing. Siting guidelines prepared by Washington State Department of Ecology require minimum depth and current requirements to ensure that the environment is protected while the fish prosper. The recent mortalities at two farm sites in Port Townsend caused by an unknown toxin in the water, points out the sensitivity of the farmed fish in a compromised environment. These fish are biological monitors, and along with our shellfish, are among the first to alert us to potential problems with water quality.

References

1. Hedrick, R.P., M.L. Kent and R.J. Toth, 1986. Myxosporeans Detected in Non-Salmonid Fishes from Water Enzootic for Proliferative Kidney Disease (PKD). American Fisheries Society/Fish Health Section, Newsletter 14(2): 4.
2. Hicks, b.D. and H.W. Ferguson, 1986. Proliferative Kidney Disease in Arctic Char (Salvelinus alpinus) from Newfoundland. American Fisheries Society/Fish Health Section, Newsletter 14:6.
3. Needham, T., 1981. What sort of disease protection do we want? Fish Farmer 4: 19.
4. Neuman, S.G., 1986 - In Aquaculture Digest.
5. Ostland, V.O., B.D.Hicks and J.G. Daly, 1987. Furunculosis in Baitfish and its Transmission to Salmonids. J. Aquatic Anim. Dis. - in press.
6. Wedemeyer, G.A., F.P. Meyer, and L. Smith, 1976, Environmental Stress and Fish Disease, T.F.H. Publ.

A STIR IN THE SALMON MARKET

How new supplies
are changing the picture.

BY PEGGY PARKER



Salmon farmers are banking on high quality and reliable supply to sell their fresh product, while domestic producers of wild-caught fish are looking to create a market niche based on the price and year-round availability of high-quality frozen salmon.

Despite the salmon family's abundant market forms and diverse species, the attention of today's market seems riveted on fresh and frozen salmon, both farmed and wild.

Much of the stir in the fresh market is due to the Norwegians, who began exporting large volumes of fresh Atlantic salmon to both the East and West coasts in the early 1980s. The Norwegian exports meant that, for the first time, high-quality fresh salmon was available in the winter — and in reliable quantities.

It used to be that fresh salmon was sold only from June to September. There were regional exceptions where winter runs of kings or steelhead (a member of the trout family, often sold as salmon) put fresh salmon on the tables of gourmet restaurants in February and March, but volumes were minuscule. The savvy Norwegians created a whole new market with their product, a market that went far beyond the niche of the domestic product in winter.

The urge to target this market is strong among domestic producers: returns are high, and the potential for growth is excellent. There are only two rules in this high-stakes game, but they must be followed to the letter. First, the product must be of highest quality; and second, supply must be

reliable.

Salmon producers are taking two approaches to the market. One is to join the competition. Interest and investment in farming operations are high on the coasts of both Canada and the U.S. Another is to promote high-quality frozen salmon as a product that meets the aesthetic standards of fresh, yet is available — usually at lower prices — all year.

The Alaska Seafood Marketing Institute introduced "Premium Quality" salmon to the winter market this year in an effort to prove that frozen salmon beats fresh in the overall picture. The cohos selected for the promotion were troll-caught, bled and immediately iced on board, then frozen on shore using meticulous handling techniques.

No time for kid gloves

But it is unlikely that Alaskan plants will produce an elite product in great quantity anytime soon. With half a billion pounds of salmon returning to Alaskan rivers in a period of four months, processors have little time for kid-glove treatment on the majority of the catch.

Harvest timing is more critical with salmon than with any other seafood. Wild salmon must be caught



between the time they enter the fishing grounds (often a several-hour boat run from the fish plant) and the time they reach the fresh water of their spawning streams. It is during this window of time — often only a matter of hours — that wild salmon are at their peak.

Processors market the cream of this crop — troll-caught chinooks and cohos and gillnet-caught sockeyes — to high-ticket restaurants. Like fine wine, they are sold with the area of origin and the date of harvest identified. While the percentage of wild salmon that is sold fresh or frozen is much higher than it was six years ago, growth in this area has slowed. Last year, fresh and frozen salmon amounted to 53 percent of the entire pack, 10 percent below the 1985

figure. Short-term growth in the market for fresh and frozen salmon will most likely come from farming operations.

A rush to the fjords

Much as in the westward homestead rush of the 1850s, salmon farmers are stampeding to the fjords of Maine, Washington, and British Columbia to set up sea pens and claim their share of the market. The U.S. has been slow to embrace sea-pen salmon farming, but British Columbia has issued more than 100 permits for the floating farms.

In July 1984, the B.C. Salmon Farmers Association was formed to allocate eggs from the federal hatcheries (the surplus from the government's salmon-enhancement program) to the farmers. Today the industry-funded group not only divvies up the eggs, but screens them for disease. B.C. farmers are building their own brood stock for secure supply and quality. Garth Hopkins, the association's director of communications, says, "In another five to seven years, we will be self-sufficient on eggs."

Following the Norwegian lead, Hopkins' group is developing a marketing strategy for B.C. salmon. It expects to implement the plan before the end of the third quarter this year. Membership, at 75 firms today, is expected to grow to 250 by next year. B.C. production of farmed cohos and chinooks was about 500 metric tons last year. In 1988, that number is expected to reach 10,000 mt.

Right now, world production of farmed salmon is less than 50,000 mt. But salmon farms in New Zealand and Chile are just beginning to produce salmon in large volumes, and in the U.S., successful farms are expanding in Washington and Maine, while others wait in line for permits.

The world's first land-based fish farm is expected to open in June in Westport, Washington. Financed by Seacom A/S of Norway, the plant will raise pan-sized coho in salt water pumped from the ocean. A second facility is slated to open in British Columbia in August.

In Alaska, where pen-rearing of salmon is illegal, the legislature is considering a bill to develop a mariculture industry.

"Although the Norwegians certainly have a jump on prospective Alaska fish farmers," says Brent Paine of the Alaska Mariculture Association, "we do have some advantages, such as sharply lower transportation costs, no import duties, and the lack of currency fluctuations between producers and customers." Paine has marketed Nor-

1986 U.S. Imports of Salmon (IN METRIC TONS)		
FROZEN:		FRESH:
136.9	NORWAY	8,871.4
5,078.6	CANADA	2,485.0
4.2	CHILE	680.8
3.0	U.K.	367.5
263.0	OTHER	540.7
5,486.0	TOTAL	12,945.4
GRAND TOTAL FRESH & FROZEN: 18,431.4		

wegian salmon in the U.S. and worked on fish farms in both the U.S. and Norway.

Will prices drop?

These advantages and high wholesale prices are what make the gamble worth it for many aquaculturists in North America. But will rapid growth in the farmed sector mean a drop in prices at the wholesale level?

Norwegian producers are betting their kroner that the market will expand to support price levels, even with the added supply. Their strategy is to provide consistently excellent fish, and sell them with flair. Branded products — not often seen in the fresh-seafood market — will become more common. Designer tags in the gill plate, such as MOWI of Norway's "Superior" tag, have great snob appeal; they also identify the fish and guarantee quality standards. The Scottish Salmon Growers Association now marks its boxes with a special "British Food Quality, Scottish Salmon" stamp. The Shetland Seafood Quality Company and the Shetland Salmon Farmers Association use a grading scheme that awards top quality a "Grade A" sticker.

But not all salmon-farming countries have the quality schemes of Norway, the U.K., or Canada. Some brokers fear that large volumes of farmed salmon may be "dumped" at low prices to gain a foothold in the U.S. market in the next year or so. That could be disastrous to small or recently established farming operations, but the major producers would likely survive.

Just how large could U.S. imports become, and how does that potential compare with domestic supply?

Norwegian salmon farmers are now producing about 30,000 mt per year. Of that amount, about 9,000 mt reached the U.S. market last year, an increase of 34 percent over 1985 imports. Total imports from other countries were just over 18,000 mt.

U.S. fishermen landed 285,000 mt last year, of which about 110,000 mt were exported. About 100,000 tons went into the domestic canned market, leaving about 75,000 mt in the domestic fresh/frozen market. Imports from all countries, then, account for about 24 percent of the domestic supply of fresh and frozen salmon.

These figures could change rapidly. Japanese sea ranching could supply more of that country's needs for salmon, which would leave more sockeyes and cohos for the domestic market. Alaska salmon landings are mercurial, but generally have been increasing over the past decade. Imports are likely to rise — perhaps even double — in the next five years. But a rapidly expanding market will move these supplies quickly. □

What is real?

A word or two about real salmon. There are two genera, or classifications of salmon: *Oncorhynchus* (on ko rin kus) and *Salmo*. Members of the *Oncorhynchus* genus are found in the Pacific and are all called salmon. Members of the *Salmo* genus are most often found in the sea pens of Norway (although there are still some small wild runs in the Atlantic), and are called, depending on the species, either salmon or trout. The fish that created such a splash on the winter market in the early 1980s is *Salmo salar*, or Atlantic salmon. In the wild, both Pacific and Atlantic salmon hatch in streams, migrate to open ocean for a growing period, then return to the streams of their birth to spawn. A major difference between the two groups is that *Oncorhynchus* spawn once and die; *Salmo* spawn several times.

cost of
production

January 28, 1988

Management
Consulting

Mr. Paul Peyton
Director, Division of Business Development
Department of Commerce & Economic Development
State of Alaska
Juneau, Alaska

Dear Paul:

The purpose of this letter is to provide you with a progress report of our study of the feasibility study of pen-rearing salmon in aquaculture.

Our progress is described in three areas:

- . comparative cost of production analysis;
- . cost of production analysis; and
- . site suitability of pen-rearing salmon in Alaska.

Comparative Cost of Production Analysis:

For each major supply region we are developing cost of production models for a typical size farm. The following format for presentation will be followed for each region:

- . Farm Management Plan
- . Capital Investment
- . Production Assumptions
- . Costs of Major Inputs
- . Costs of Production

The comparisons between Norway, Scotland, Chile and B.C. are nearly completed. For Japan we have not yet received any cost data. However, a comprehensive report on the Japanese salmon farming industry is being sent to us by the U.S. Embassy in Tokyo. Combined with information Trond Bjorndal collected on a recent visit to Japan, we should be able to come up with a similar profile as the other industries.

To determine the level of government support provided to each industry we made requests to agencies in each country. These include:

Norway	Ministry of Fisheries, Norway
Scotland	Highland & Islands Development Board, Scotland
Chile	Subsecretariat de Pesca, Chile
B.C.	B.C. Ministry of Agriculture and Fisheries and Department of Fisheries and Oceans
Japan	U.S. Embassy in Tokyo

To date, we have received results back for Norway and B.C. We expect to receive the results from the other regions shortly.

We anticipate that an interim report on the comparative cost of production analysis will be ready by February 15th.

Cost of Production Analysis

Our cost model study for the B.C. Ministry of Agriculture and Fisheries has progressed somewhat slower than anticipated because of a small delay in finalizing the contract and it has taken more time than anticipated for B.C. Research to provide us with the growth data. As a result, the first prototype model is not expected to be completed until the first week of February.

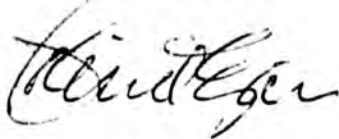
Site Suitability Analysis:

We have obtained excellent data from Alaska on environmental conditions. Preliminary analysis indicate the following findings:

- . Winter ice covering is a major obstacle to salmon farming in Cook Inlet.
- . Icebergs calving in Prince William Sound and northern Southeast Alaska cause very cold summer temperatures and limit production in these areas.
- . In Southeast Alaska, conditions are quite different between east and west. On the eastern side there is a strong oceanographic influence. While temperatures are lower they are more stable and salinities are higher and more stable, suggesting that this may be the most suitable area for salmon farming.

This analysis will be completed in early February. We feel confident that we can then adjust the B.C. growth curves for chinook and coho to conditions in Alaska based on published data available on the relationship between temperature and growth.

Yours truly,

A handwritten signature in cursive script, appearing to read "David Egan".

David Egan
Senior Consultant

DE:kp

Overview of the B.C. Aquaculture Industry

Prepared by

THE DPA GROUP INC.

Vancouver, B.C.

January, 1988

Production

Production in 1986 and 1987 is shown below:

B.C. SALMON AQUACULTURE PRODUCTION (metric tonnes)

Species	1986 ¹	1987 ²
Chinook	89	600
Coho	<u>400</u>	<u>900</u>
	489	1,500

Sources: 1 Fisheries Production Statistics of British Columbia, B.C. Ministry of Agriculture and Fisheries
 2 B.C. Salmon Farmers Association estimates

Industry Structure

The number of operating saltwater sites has increased from 54 in 1986 to 113 in December, 1987. Areas with the largest amount of new development were north of Campbell River. According to a recent survey conducted by the B.C. Ministry of Agriculture and Fisheries, the total installed net pen capacity in B.C. was 2.12 million cubic metres. At average stocking densities of four kilograms per cubic metre, the total production capacity was about 8,500 tonnes. However, most of the increase in production capacity in 1987 was not from new entrants but from the expansion of a few large farms. For example, Aquarius Seafarms, B.C.'s largest farm, announced plans to double its production capacity from 2,000 tonnes to 4,000 tonnes beginning in the fall of 1987.

New investment was shown by existing Canadian seafood processors, including the purchase of Pacific Aqua Foods by National Sea Products Inc., one of Canada's largest integrated seafood companies. Foreign investment, particularly from Norway, also increased substantially in 1987.

Smolt production capacity in the industry also increased significantly in 1987 to about 30 million smolts. Most of the expansion in capacity was by existing smolt producers already integrated with fish farms.

Feed production is becoming increasingly dominated by the two foreign-owned feed manufacturers: Moore-Clark, a subsidiary of Trouw, the specialty feed division of B.P. Nutrition Ltd. and EWOS Canada Ltd.

Costs of Production

Costs of production at an industry level are not known because costs of production surveys have yet to be undertaken. It is therefore difficult to generalize the industry's financial performance.

In comparison to livestock industries, the salmon farming industry has a high cost structure. For example, feed, the largest operating cost in salmon farming, is now about \$1,000 tonne, or about three times the cost of chicken feed.

Based on cost models developed by DPA for individual farms, cash costs of production range between \$4.00 and \$5.00 per kilogram. Unit cost data for a typical farm is being developed by DPA in an on-going study being conducted jointly with B.C. Research for BCMAF. In the study, growth data from about 20 fish groups at 25 farms, developed by B.C. Research from a broodstock management program, form the basis of the model.

Processing and Marketing

The majority of production in 1987 was processed and marketed by seafood processors in B.C. namely, B.C. Packers Ltd. and J.S. MacMillan Fisheries Ltd.

In turn almost all production is being sold by these processors to seafood wholesalers in major cities outside of B.C., particularly in central Canada and the U.S.

Farmed salmon prices like most seafoods were very high in 1987. However, production was almost entirely in the 2-4 pound and 4-6 pound size categories and as a result sold for less than Norwegian and Scottish farmed salmon in larger size categories. In future when competition increases, it will be critical that the industry produce fish in excess of 6 pounds.

The B.C. Salmon Farmers Association began a generic promotion campaign in 1987, advertising the availability of fresh B.C. salmon in seafood trade journals. The BCSFA was also presented at several major seafood trade shows.

CONSTRAINTS

Egg Supply

Acute chinook egg shortages occurred in 1987 when low returns were caused by low water levels in rivers throughout the province. The low water levels were caused by an unusually dry autumn. The salmon farming industry expected to receive 20 million chinook eggs from DFO but only received 2-3 million eggs. Unlike previous years, farmers were reluctant to switch to coho eggs which were more plentiful, because of high jacking rates with regular coho and slow growth with neutered coho. A further 8 million chinook smolts from domestic broodstock should be available bringing the total

to about 10 million smolts. This means that smolt production in the spring of 1988 will be about one-third of its potential and production in 1989/90 will be less than earlier projected.

Financing

Financing is one of the major constraints facing the industry. Lack of financing resulted in several bankruptcies, reorganizations and mergers in 1987. With the exception of financing provided by seafood processors, access to capital is largely limited to those who have access to foreign sources. For example, the majority of the combined \$25 million in financing obtained in 1987 by Aquarius Seafarms and Royal Pacific Seafoods, two of the three largest fish farms in B.C., was financed by European sources.

No Canadian banks, including the Federal Business Development Bank are providing loans to the industry unless they are fully guaranteed (by other than inventory and/or accounts receivable). In addition, the Western Diversification Program has not yet made any loans to the industry.

The financial assistance programs offered by BCMAF and the joint federal/provincial Subsidiary Agreement on Industrial Development to the industry are limited to a maximum of \$300,000 and \$100,000, respectively, per farm. The total outstanding loans at the end of 1987 from these programs were \$0.3 million and \$3.8 million, respectively. Since the total average working capital requirements for a typical farm can often exceed \$1 million, these programs can only provide a portion of most farms' total financing requirements.

Fish Feed

Improved husbandry has led to improved growth and survival rates in the industry. However, the industry is still faced by severe production constraints. These include the high

incidences of diseases, particularly bacterial kidney disease, and the lack of domesticated strains of Pacific salmon.

New evidence is suggesting that the quality of feed may be one of the major impediments to overcoming these constraints. An on-going study being conducted by DPA to develop an industry strategy for access to high quality raw materials for feed has found that the most important raw materials in fish feed being used by the feed industry in B.C. have nutritional deficiencies. These can likely be overcome by a combination of the use of higher quality raw materials produced in an improved reduction process. However, there are several biological, technical, economic and regulatory barriers to achieve these objectives. As a result, the industry's high cost structure is likely to continue in the short and medium term, particularly in the absence of major public or private research programs targetted at adult Pacific salmon.

DRAFT

World Markets for Salmon: Pen-Reared Salmon Impacts

LIST OF CONTENTS

Section	Content	Page
1.	EXECUTIVE SUMMARY	
1.1	Project Background	
1.2	Alaskan Wild Salmon Industry Overview	
1.3	World Farmed Salmon Industry Overview	
1.4	Salmon Market Conditions	
1.5	Potential Market Competition	
1.6	Conclusions	
2.	INTRODUCTION	
2.1	Project Background	
2.2	Objectives	
3.	ALASKAN WILD SALMON	
3.1	Industry and Market Overview	
3.2	Species	
3.2.1	Chinook	
3.2.2	Coho	
3.2.3	Sockeye	
3.2.4	Chum	
3.2.5	Pink	
3.2.6	Life Cycle	
3.2.7	Pacific and Atlantic Differences	
3.3	Market Channels	
3.3.1	Domestic	
3.3.2	U.S. Fresh Salmon Shipping Methods	
3.3.3	U.S. Salmon Consumption Demographics	
3.3.4	Export	
3.4	Price Trends	
3.5	U.S. Salmon Exports	
3.6	Export Requirements	
3.6.1	Japan	
3.6.2	U.K.	
3.6.3	France	
3.6.4	F.R.G. Germany	
3.6.5	General Observations	
4.	FARMED SALMON	
4.1	World Overview and Trends	
4.2	Production Trends By Major Producing Countries	
4.2.1	Norway	
4.2.2	Scotland	
4.2.3	Iceland	
4.2.4	Faroe Islands	

World Market
Study

LIST OF CONTENTS CONT'D

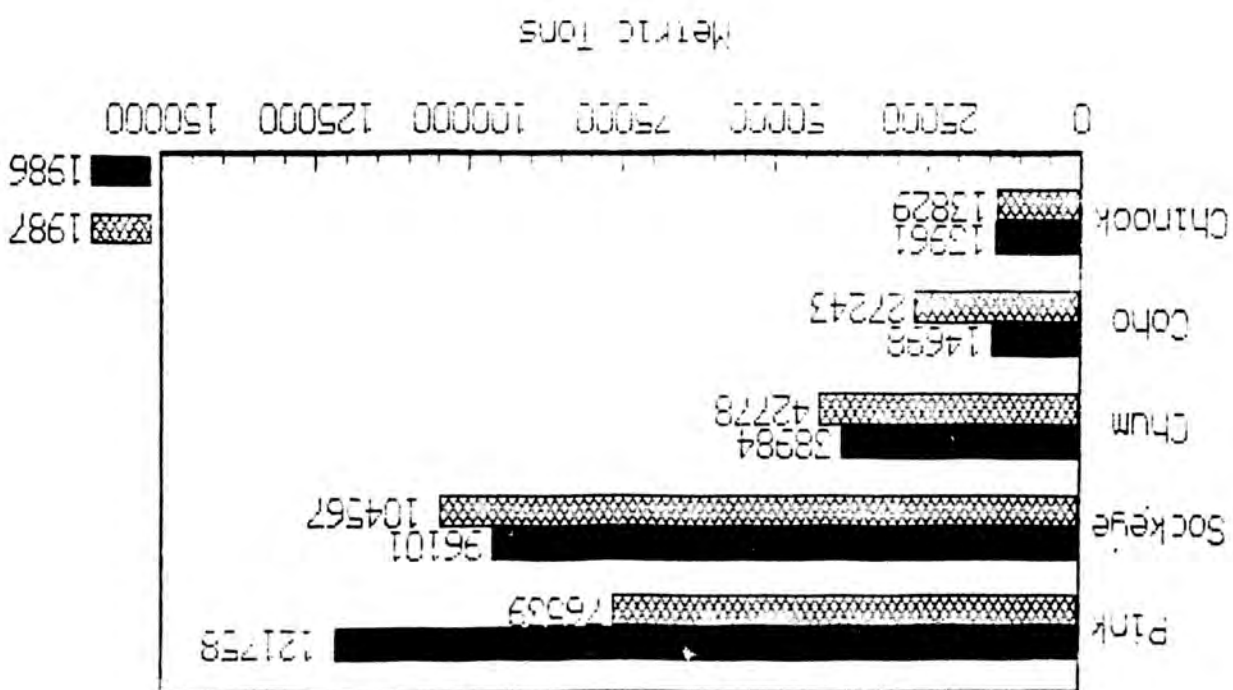
- 4.2.5 Japan
- 4.2.6 Canada
- 4.2.7 Ireland
- 4.2.8 Chile
- 4.2.9 New Zealand
- 4.3 Major World Farmed Salmon Markets
 - 4.3.1 U.S.
 - 4.3.2 Japan
 - 4.3.3 France
 - 4.3.4 F.R. Germany
- 4.4 U.S. Price Trends of Farmed Salmon
- 4.5 Effects of the Exchange Rate
- 5. MARKET FORECASTS
 - 5.1 Production Projections
 - 5.1.1 Alaska Wild Salmon Harvest
 - 5.1.2 Major Farm Salmon Producing Countries
 - 5.2 Markets and Price Level Expectations
 - 5.3 Potential Market Competition
 - 5.3.1 Alaskan Wild With Alaskan Farmed
 - 5.3.2 Alaskan Wild & Farmed With Foreign Farmed
- 6. CONCLUSIONS

- APPENDICES:
- A: References
 - B: Tariff Schedules for Major World Salmon Markets
 - C: Glossary of Salmon, Market and Economic Terms

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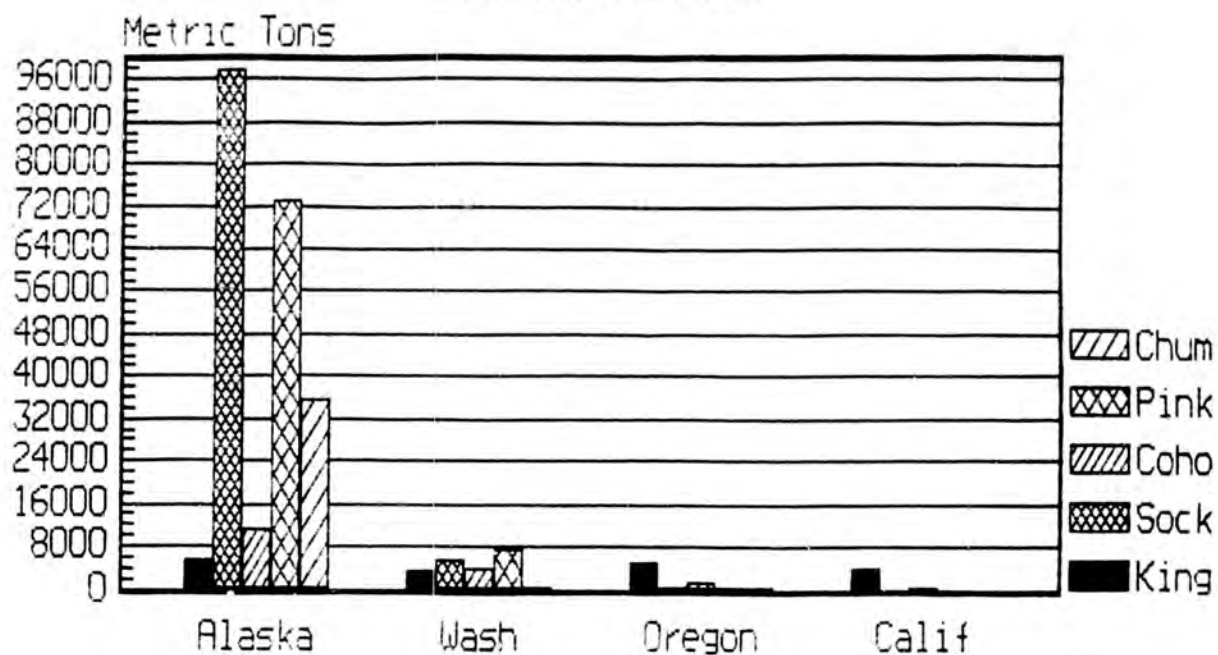
U.S. Fish and Wildlife Service
 1986=258,047
 1987=252,411

Source: Seafood Legend



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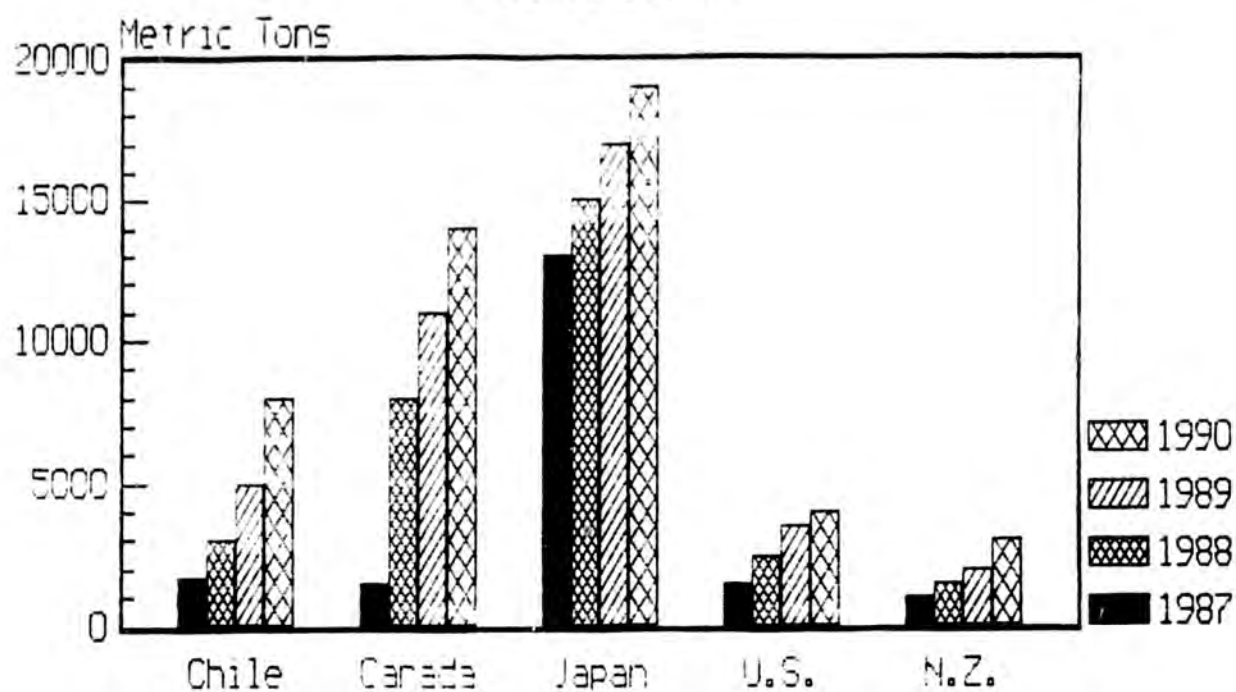
1987 U.S. Pacific Salmon Catch
By State
(Preliminary Data)



Source: State's Dept's of F&G

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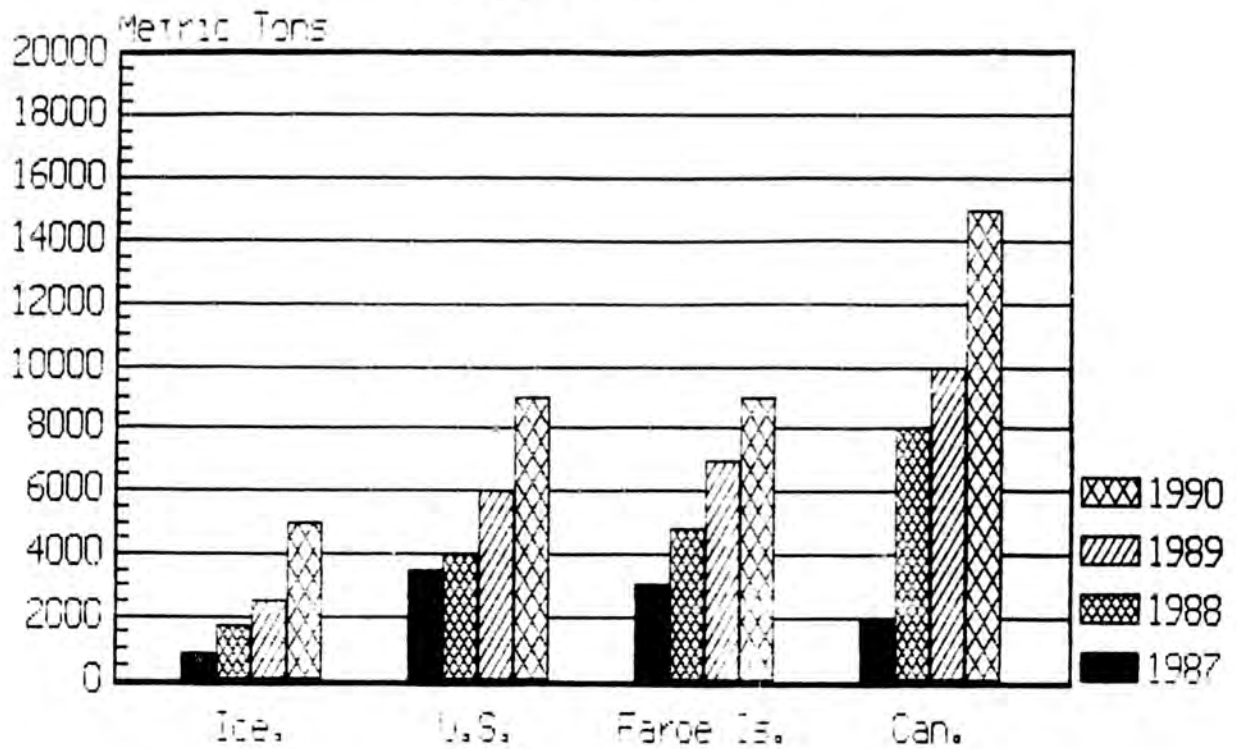
Projected Production of Farmed
Pacific Salmon



Source: Sea Fare Group

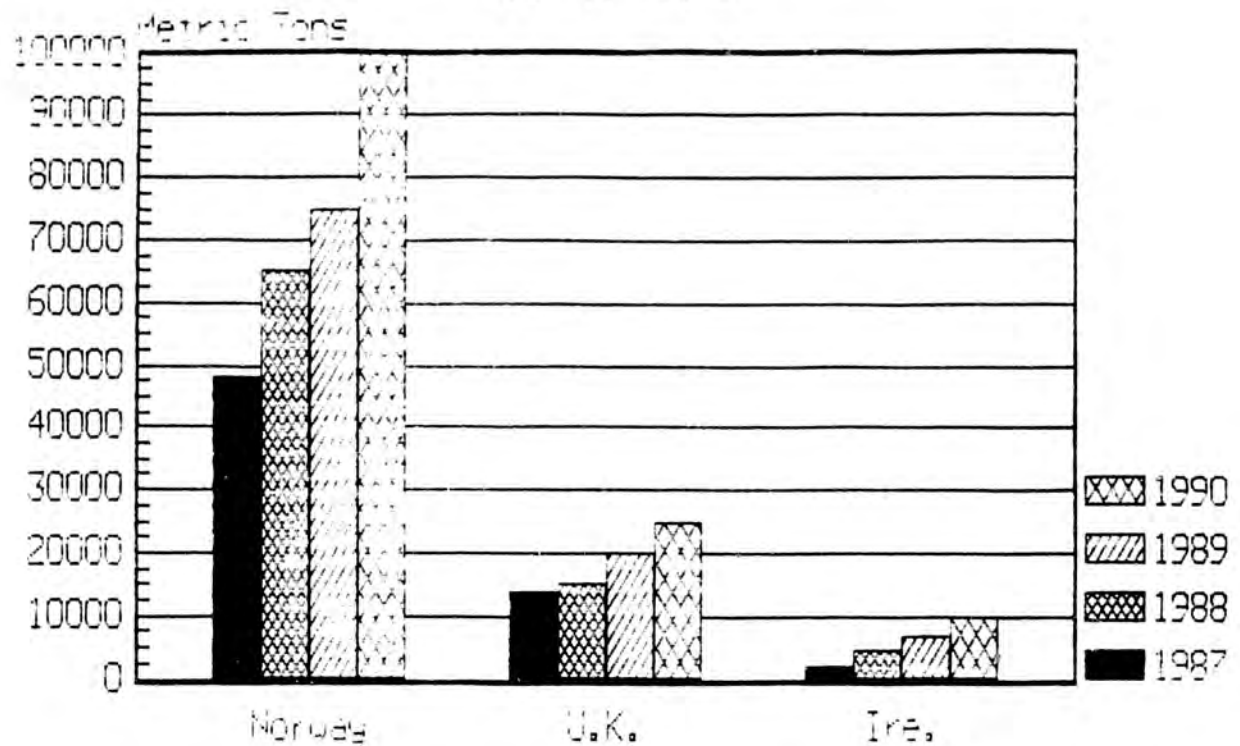
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Projected Production of Farmed
Atlantic Salmon



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Projected Production of Farmed
Atlantic Salmon



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World Production of Farmed Salmon

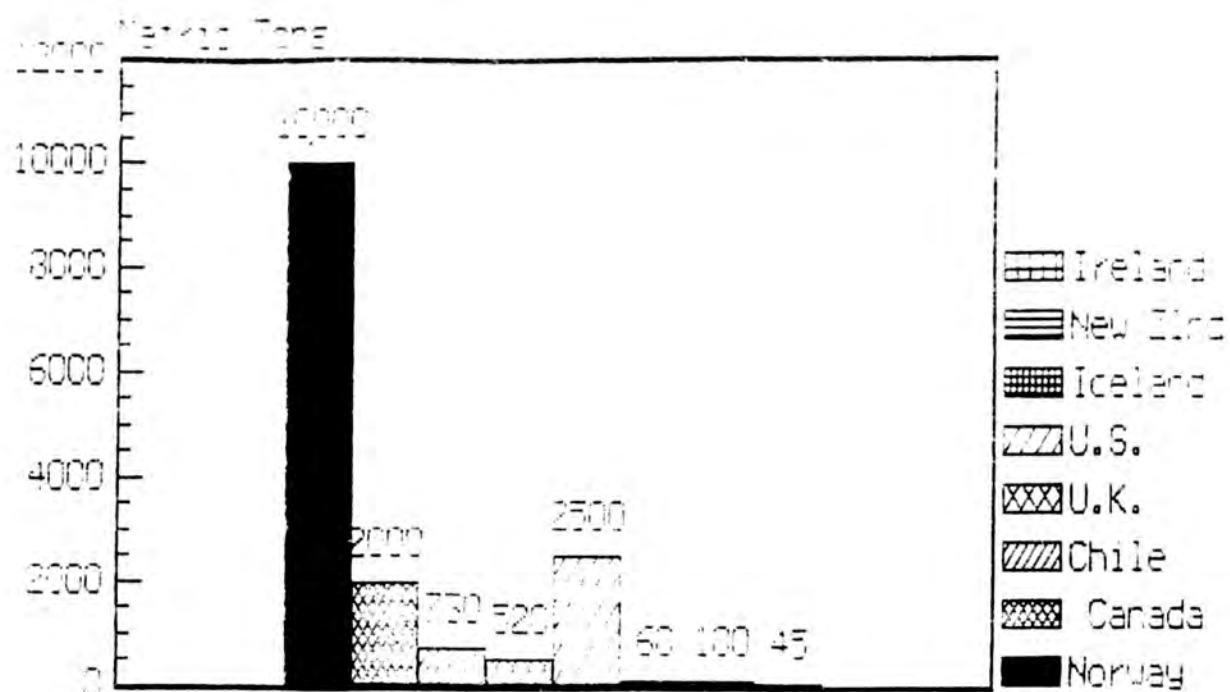
By Species and Quantity
(MT)

<u>Year</u>	<u>Atlantic</u>	<u>Pacific</u>	<u>Total</u>
1982	12,812	2,584	11,244
1983	20,213	1,992	22,205
1984	27,184	5,375	32,559
1985	37,399	7,450	44,849
1986	60,006	10,394	70,400
1987	75,259	20,120	95,379

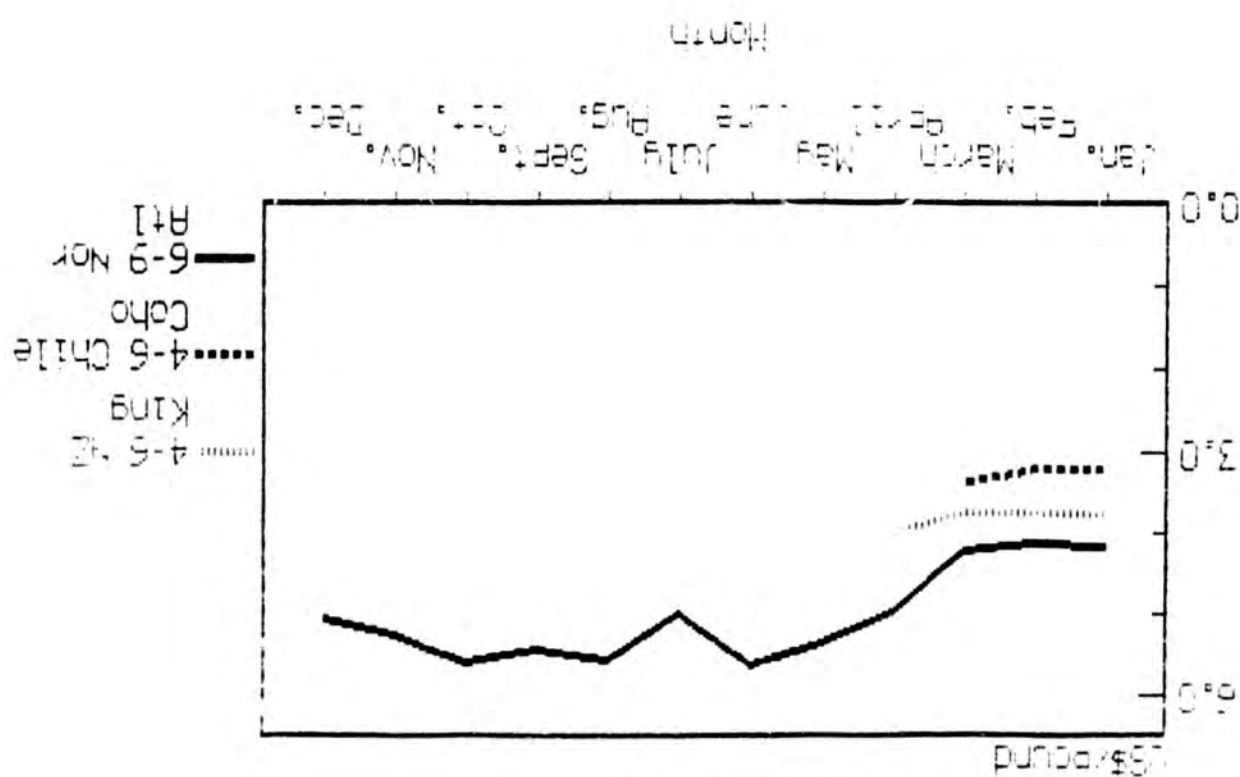
Source: World Salmon Aquaculture, 1980-87
NMFS (Draft, Oct. 1987)

DRAFT

U.S. Supplies to Far East, 1945-1957



Source: Sea Fare Group



1970

1971



3510 1st Ave. NW

Seattle, WA 98107

206/547-6030

Telex 298 558 SFE UR

INVOICE

Bill To: State of Alaska
Department of Commerce and
Economic Development
Division of Business Development
333 Willoughby
Juneau, Alaska 99811
ATTN: Mr. Paul Peyton

Members
Russ Lamb
Catherine Olier
Sandi McKenzie
Peter Redmayne M.M.A.
Roland Henin C.M.C.
Jill Hertzke
Michele Tennyson

Date: February 2, 1988

RE: Project 88-198
World Markets for Salmon--Pen-Reared Salmon Impacts

Invoice No. 1 of 2

Amount due for professional services
rendered to date = \$10,000
(See attached Interim Report
of today's date)

(Total contract amount= \$20,000 - 10,000 = 10,000 remaining
balance for Invoice No. 2 on completion of project)



Mr. Paul Peyton
Department of Commerce and Economic Development
Division of Business Development
333 Willoughby
Juneau, Alaska 99811

3510 1st Ave. NW

Seattle, WA 98107

206/547-6030

Telex 298 558 SFE UR

February 2, 1988

RE: Interim Report, World Markets for
Salmon--Pen-Reared Salmon Impacts,
88-198

Members

Russ Lamb

Catherine Oller

Sandi McKenzie

Peter Redmayne M.M.A.

Roland Henin C.M.C.

Jill Hertzke

Michele Tennyson

Dear Paul,

As we discussed last Friday, this letter will provide you with an overview of where our investigations stand to date and how we plan to proceed in the remaining weeks.

In addition, we have attached a copy of the table of contents from our draft baseline report. Dr. Anderson will be expanding the number of Market Forecast sections once he performs his computer analysis. We have also attached, for your information, several tables and graphs generated from our progress thus far.

Per our contract, also enclosed is our invoice for services rendered to date.

Just to reiterate, the overall objectives of this study are to, 1) Provide a baseline of production and marketing information, and address the potential for market competition between 1) Alaska wild salmon fisheries and Alaska pen-reared salmon, and 2) farmed salmon from any country with either type of Alaska salmon.

Task 1: Baseline Market and Price Information

Wild Salmon

A thorough overview of the Pacific salmon fishing industry and markets has been done. The Consultants identified, collected and reviewed available literature and information pertaining to the five Pacific species, their biological cycles, landings, catch methods, seasonalities and usual product forms.

Quantities of U.S. salmon exports have been gathered as well as the tariff schedules for the major world salmon markets. A description has been drafted about the general market characteristics of these countries and guidelines for purchase arrangements with them.

February 2, 1988
Page 2

Market and distribution channels for the U.S. as well as those countries identified as major world markets in salmon are also defined and illustrated. This also includes the typical fresh salmon shipping methods and packaging. Based on available secondary information, the demographics of salmon consumption in the U.S. is described.

With a number of gaps, price data has been collected for the Pacific species over the past ten years. We are looking for additional sources of information.

As you mentioned Paul, the economic study which was undertaken by the State of Alaska but unfortunately not completed due to lack of funding, would be very helpful, even if it is just raw price data. We would appreciate receiving this information as soon as possible.

In the mean time we will utilize other sources of price data and continue to work with the information we have.

Farmed Salmon

Data has been collected and assembled pertaining to the current and projected production of world farmed salmon. The major producing countries are identified and their production levels are given for the past five years. General information about their salmon farming industries is also described.

Most major farmed salmon producing countries have estimates of projected production to the year 1990, several to 1995, but most of these latter figures are very suspect.

This will give indications as to the amount of farmed salmon which will be entering the world markets.

Price data for the major exporting countries to the U.S. has been collected, although there are some gaps at this time in the data due to many pricing sources not really tracking the prices of farmed salmon until the past couple of years. Further discussions with price sources are continuing to determine where the information can be obtained to fill the gaps.

The major world markets for farmed salmon have been described. The quantities of imports and exports, preferred species, product forms, sizes and market channels are presented.

Preliminary information has been gathered concerning the effects of the exchange rate on international trade in salmon by the Consultants, and more will be written as Dr. Anderson proceeds with his analysis.

3
Mr. Paul Peyton
February 2, 1988
Page 3

Task 2: Market Forecasts

Concerning the future markets, price level expectations and degree of market competition, last week Sea Fare Group with Dr. Anderson and his associates performed a series of surveys in the Seattle area with Japanese trading companies, restaurants, individual supermarket behind-the-counter staff as well as seafood buyers for supermarket chains and large wholesale/distributors.

We also plan to conduct phone interviews with Southern California supermarket seafood buyers as well as several salmon smoking companies here in Seattle. This would provide an adequate sample for the West Coast.

These surveys are similar to the surveys Dr. Anderson used in his East Coast studies. They will provide answers to questions including the seafood buyers' species preferences, the influence of price on the decision, species substitutability and perceived differences between wild and farmed salmon, if any perceptions are held by the buyer, preferred packaging and shipment sizes.

A large amount of data has been collected through the surveys and will be entered into the computer for analysis.

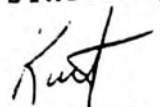
As the input by Dr. Anderson is received by us, we will begin the task of editing and merging it with our report.

In regards to our discussions last Friday concerning the time schedule for this project, we will continue on the premise that it remains unchanged until we hear from you otherwise, with the draft report due on February 26 and the final report due on March 4.

In our discussions it was determined that an additional week or two would assist the consultants in preparing a more finalized quality report, as well as preparations for a workshop or presentation in Alaska. You indicated the possibility of extending the project due date to perhaps March 11 for the final report and a presentation on the 18th, but this would first have to be approved by either you or your office.

Please let us know as soon as you can concerning the decision on the project completion date. Should you have any questions regarding this interim report or the project due date please give us a call.

Sincerely,

A handwritten signature in dark ink, appearing to read 'Kurt', with a stylized flourish extending from the end.

Kurt Jacobsen

encls.

Se

**MARKET ACCESS
AND
PENETRATION STRATEGY
B.C. FARMED SALMON**

FINAL REPORT

The DPA Group Inc.

MARKET ACCESS AND
PENETRATION STRATEGY
B.C. FARMED SALMON

FINAL REPORT

Prepared for:

B.C. Salmon Farmers
Association

Prepared by:

The DPA Group Inc.
and Dr. J. Anderson
and Michael D. Hurst
File: 14487

February, 1987

ACKNOWLEDGEMENT

This study was funded by the British Columbia Salmon Farmers Association and the governments of Canada and British Columbia under the Opportunity Identification and Assessment Program of the Canada-British Columbia Subsidiary Agreement on Industrial Development. The opinions expressed in this report are those of the consultants only who accept full responsibility for any errors or omissions.

TABLE OF CONTENTS

1.0	STUDY PURPOSE AND METHODOLOGY	1-1
1.1	Purpose	1-1
1.2	Methodology	1-2
1.3	Report Organization	1-7
1.4	Overview of the Product	1-9
1.5	Potential Markets	1-12
2.0	WORLD MARKETS FOR B.C. FARMED SALMON	2-1
2.1	Introduction to World Markets for Fresh and Frozen Salmon	2-1
3.0	CURRENT AND POTENTIAL DEMAND FOR FRESH AND FROZEN SALMON IN NORTH AMERICA	3-1
3.1	Current Demand	3-1
3.2	Potential Demand	3-6
3.3	Summary and Implications of Demand Projections	3-8
4.0	BUYER PREFERENCES BY MARKET SEGMENT	4-1
4.1	Purchase Criteria	4-1
4.2	Preferences Among Salmon Products	4-13
4.3	Summary and Implications for B.C. Farmed Salmon	4-16
5.0	PROJECTED SUPPLIES OF FARMED SALMON IN NORTH AMERICA	5-1
6.0	KEY MARKETING ISSUES AND PROBLEMS	6-1
6.1	Demand-Related Issues	6-1
6.2	Market Structure and Coordination Issues	6-11
6.3	Supply-Related Issues	6-17
7.0	PRODUCT POSITIONING AND TARGET MARKET IDENTIFICATION	7-1
7.1	Competitive Advantages	7-1
7.2	Competitive Disadvantages	7-4
7.3	Product Positioning	7-5
7.4	Target Markets	7-7
8.0	PRODUCT STRATEGY	8-1
8.1	Overview of Key Issues	8-1
8.2	Recommended Strategies	8-2

9.0	PRICING STRATEGY	9-1
9.1	Overview of Key Issues	9-1
9.2	Recommended Strategies	9-3
10.0	DISTRIBUTION STRATEGY	10-1
10.1	Overview of Key Issues	10-1
10.2	Recommended Strategies	10-2
11.0	PROMOTION STRATEGY	11-1
11.1	Conventional Approaches to Seafood Promotion	11-1
11.2	Generic Versus Firm Specific Promotion	11-3
11.3	Targetting to Specific Market Segments	11-6
11.4	Recommended Strategies	11-7
12.0	ROLE OF THE BCSFA IN MARKETING	12-1
12.1	Introduction and General Principles	12-1
12.2	Recommended Marketing Role	12-3
12.3	Planning Timetable	12-14
12.4	Funding Implications	12-16
APPENDIX A: Existing and Potential Salmon Demand by State		
APPENDIX B: Description of the Seafood Distribution System		
SELECTED BIBLIOGRAPHY		

Salmon has a high quality image in European countries, and markets for fresh salmon will continue to grow because of rising per capita incomes and existing low per capita consumption levels. However, some market analysts feel that further growth in demand will depend on decreases in the real price of Atlantic salmon. A recent University of Stirling study concludes that a price decline of 20-30% at the retail level would be sufficient to absorb the expected doubling of Atlantic farmed salmon supply by 1990.

B.C. farmed salmon producers would have great difficulty successfully competing in Europe because the competitive position of producers of farmed Atlantic salmon is very strong, due to proximity to markets and changing preferences toward Atlantics. European prospects for B.C. farmed salmon are not expected to improve given anticipated real price declines for Atlantic salmon. Significant air transportation costs will probably lead to uneconomic prices at the B.C. producer level.

At present, North America represents the largest, most immediate market for B.C. farmed salmon. In particular, the U.S. marketplace has the greatest potential for sales. For this reason, our research efforts concentrated on that market. The following section describes the North American market for fresh and frozen salmon in more detail, providing estimates of current and potential demand by principal market segment and region.

3.0 CURRENT CONSUMPTION AND POTENTIAL DEMAND FOR FRESH AND FROZEN SALMON IN NORTH AMERICA

This section describes the current size of the fresh and frozen salmon market in North America by region and market segment and presents the results of the conjoint analysis indicating the growth potential of each segment.

3.1 Current Consumption

No statistics are available on the amount of fresh salmon consumed in the U.S. and Canada; nor is there much data on the quantity of fresh or frozen salmon shipped into food service and retail markets.

We used two approaches for estimating current consumption. Both yielded similar results. One estimate of total consumption can be derived from analysis of catch and other statistics, as shown in Exhibit 3.1. Consumption in the U.S. is calculated as a residual amount. In contrast to the U.S., Canadian production of fresh/frozen salmon is actually compiled. (Only B.C. production totals are included in the Canadian total because Atlantic production is nominal.)

EXHIBIT 3.1: SIZE OF THE NORTH AMERICAN FRESH AND FROZEN SALMON MARKET IN 1985 (TONNES)

	U.S. ¹	Canada	Total
Total Salmon Catch	329,815	38,158 ²	
Less: Exports	(151,172)	(23,698) ³	
Less: Canned pack	(112,616)		
Plus: Imports	14,474		
Changes in Inventory	<u>10,293</u>		
Apparent Consumption	70,208	14,460	84,668

Sources: 1. National Marine Fisheries Service.
 2. B.C. Ministry of Environment and Parks.
 3. Statistics Canada.

The size of the market can also be estimated by extrapolating Anderson's conjoint analysis results to the rest of North America. Using this method, the size of the fresh/frozen market is estimated at 86,200 tonnes. This figure is within 4% of the estimate in Exhibit 3.1. A further advantage of Anderson's market estimate is that it provides a detailed breakdown by both market segment and geographic area.

Size of Segments

A summary of current consumption in the U.S. in 1985 by segment is shown in Exhibit 3.2. The quantities shown are estimates only; actual quantities will vary somewhat due to idiosyncrasies in various markets.

As indicated in the exhibit, restaurants comprise the largest segment for fresh/frozen salmon. The split shown in Exhibit 3.2 is generally consistent with splits determined in other recent studies of the U.S. market, which are summarized in Exhibit 3.3. The percentage sold in each segment as identified in the Ference and Lin studies are based on surveys of wholesalers; the Oslo and Woods Gordon percentages are estimates only.

EXHIBIT 3.2: CONSUMPTION BY SEGMENT IN THE U.S. IN 1985

	Tonnes	% of Total
Food Service		
Restaurants	43,200	60%
Retail		
Grocery Supermarkets	14,100	19%
Fish Markets	<u>15,400</u>	<u>21%</u>
Total	72,700	100%

Source: The DPA Group Inc. and J. Anderson

EXHIBIT 3.3: PERCENTAGE OF CONSUMPTION IN RETAIL VS FOOD SERVICE SEGMENTS IN THE U.S.

	DPA (1985)	Ference ¹ (1986)	Rogness ² & Lin (1986)	Oslo ³ (1986)	Woods ⁴ Gordon (1983)
Food Service	60	45	59	55	50
Retail	<u>40</u>	<u>55</u>	<u>41</u>	<u>45</u>	<u>50</u>
	100	100	100	100	100

Sources:

- 1 Don Ference & Associates Ltd., B.C. Indian Aquaculture Study - Market Potential for Farm Salmon Products, B.C. Aboriginal People's Fisheries Commission, June 1986.
 - 2 R.V. Rogness, B. Lin The Marketing Relationship Between Pacific and Pen-raised Salmon: A Survey of U.S. Seafood Wholesalers, University of Alaska, Alaska Sea Grant Report 86-3, September, 1986.
 - 3 E. Dale, J. Owens, A. Stenseth: Tilling the Sea - Prospects for Norwegian Aquaculture, Royal Norwegian Council for Scientific and Industrial Research, July, 1986.
 - 4 Woods Gordon, U.S. Market Opportunities for Farmed Atlantic Salmon, New Brunswick Commerce and Development, October, 1983.
-

An analysis of production statistics for fresh wild-caught salmon from B.C. and Alaska and the level of imports of fresh farmed salmon indicate that total consumption of fresh salmon varies between a quarter and one-third of the total fresh/frozen salmon. This is confirmed by results of the survey of wholesalers conducted in the Ference study.

Exhibit 3.4 shows an estimate of fresh and frozen salmon production by species in 1984. Estimates were developed from a breakdown of B.C. wild and farmed salmon production and imports of farmed Atlantic salmon in 1984. As indicated in the exhibit, two-thirds of total production is frozen. Production of coho is highest, and is mostly frozen. Production of coho and chinook constitutes 40% of the total market. Atlantic production constitutes 11%. The majority of Atlantic is sold fresh.

**EXHIBIT 3.4: PERCENTAGE OF FRESH AND FROZEN SALMON
PRODUCTION BY SPECIES IN 1984¹**

	Frozen	Fresh	Total
Coho	22%	5%	27%
Chum	17%	6%	23%
Sockeye	12%	3%	15%
Chinook	7%	6%	13%
Pink	8%	3%	11%
Atlantic	<u>1%</u>	<u>10%</u>	<u>11%</u>
	67%	33%	100%

- 1 A breakdown for 1984 is shown because more recent statistics on fresh production from Alaska were not available.

Source: DPA Group Inc.

Atlantics, chinook, coho, and sockeye compete at the upper end of the market, as would premium quality farmed salmon products. Chums and pinks, which constitute 34% of the market, are at the lower end of the price scale. Lower quality farmed salmon products would compete in this category.

According to FAO statistics, approximately 10% of current supplies of frozen salmon production are further processed into smoked salmon.

3.1.1 Regional Demand

A summary of current demand in North America by region is shown in Exhibit 3.5. The results are extensions of Anderson's survey of buyers conducted in the spring of 1986 which reflects consumption during the June, 1985 to June, 1986 period.

As indicated in the exhibit, the U.S. represents 84% of total North American demand. Demand is highest in the Mid Atlantic region, followed by the Pacific and South Atlantic regions. Combined, these three regions represent 61% of the U.S.

demand and 52% of the total North American demand. A detailed breakdown of the U.S. market by state is included in Appendix B. As indicated in the appendix, the majority of demand in the Mid Atlantic regions is in New York and the majority of demand in the Pacific region is in California.

Canada represents 16% of total North American demand. Ontario and Quebec account for 62% of Canadian demand and 10% of North American demand. B.C., with a small population compared to other regions, accounts for only 2% of total demand.

Some differences in the relative size of segments also exist between Canada and the U.S. Canada has a higher proportion of sales to restaurants than the U.S. Also, more sales are made to grocery chainstores than to fish markets in Canada.

EXHIBIT 3.5: EXISTING REGIONAL CONSUMPTION FOR FRESH/FROZEN SALMON IN NORTH AMERICA IN 1985 (TONNES)

	Restaurants	Grocery Supermarkets	Fish Markets	Total	% of Total
US					
New England	4,600	1,000	2,500	8,200	10%
Mid Atlantic	9,000	3,300	5,000	17,300	20
NE Central	5,500	1,500	700	7,700	9
NW Central	1,100	400	100	1,600	2
SO Atlantic	5,600	2,900	3,000	12,000	14
SE Central	2,600	1,200	1,000	4,800	6
SW Central	2,700	1,400	500	4,700	5
Mountain	700	300	100	1,100	1
Pacific	<u>10,900</u>	<u>2,000</u>	<u>2,400</u>	<u>15,300</u>	<u>18</u>
	43,200	14,100	15,400	72,700	84%
	60%	19%	21%		
Canada					
B.C.	1,000	300	200	1,500	2
Prairies	1,600	500	300	2,400	3
Ontario	3,200	1,000	600	4,800	6
Quebec	2,300	800	400	3,500	4
Maritimes	<u>800</u>	<u>300</u>	<u>200</u>	<u>1,200</u>	<u>1</u>
	8,900	2,900	1,700	13,500	16%
	66%	22%	12%		
Total	52,100	17,000	17,100	86,200	100%
	60%	20%	20%	100%	

Source: The DPA Group Inc. and J. Anderson

3.2 Potential Demand

The conjoint analysis model can be used to predict growth by segment based on the availability of preferred products. In the model, preference, price, and demographic variables, such as changes in population and per capita income, are held constant. The model predicts additional quantities demanded as a result of perfect supply availability of most preferred salmon products. These were comprised of the highest-ranked products from the list of 77 we assumed would be available from a variety of farmed and wild salmon supply regions, including B.C. In effect, the buyers in the sample were asked how much more salmon they would buy at current prices if their preferred salmon products were available.

The growth potential for each segment is shown in Exhibit 3.6.

EXHIBIT 3.6: GROWTH POTENTIAL BY SEGMENT

	Existing Shares	Growth Potential	Potential Shares
Food Service:			
Restaurants	60%	42%	55%
Retail:			
Groceries/Supermarkets	20%	109%	27%
Specialty Fish Stores	<u>20%</u>	<u>43%</u>	<u>18%</u>
Total	100%	<u>overall</u> 57%	100%

As indicated above, good growth potential exists in all segments. The largest growth opportunity is in the grocery supermarket segment, but it is at present the smallest segment. Overall growth potential for all segments is 57%.

Potential demand by region for existing production is shown in Exhibit 3.7. The results are extrapolated from New England

(1572 of 1985)
at current
prices

survey data and modified to account for per capita consumption by region; the exception is Canada where per capita consumption by province is not known.

EXHIBIT 3.7: POTENTIAL REGIONAL DEMAND FOR FRESH/FROZEN SALMON IN NORTH AMERICA

	Restaurants	Grocery Supermarkets	Fish Markets	Total
US				
New England	6,600	2,200	3,600	12,400
Mid Atlantic	12,800	6,900	7,100	26,800
NE Central	7,900	3,000	1,100	12,000
NW Central	1,600	900	100	2,600
SO Atlantic	8,500	6,100	4,400	18,900
SE Central	3,800	2,500	1,400	7,600
SW Central	3,900	3,000	700	7,600
Mountain	900	700	200	1,800
Pacific	<u>15,600</u>	<u>4,200</u>	<u>3,500</u>	<u>23,200</u>
	61,400	29,400	22,100	113,000
	54%	26%	20%	
Canada				
B.C.	1,400	900	300	2,400
Prairies	2,000	1,100	400	3,700
Ontario	4,500	2,200	900	7,600
Quebec	3,300	1,600	600	5,500
Maritimes	<u>1,100</u>	<u>500</u>	<u>200</u>	<u>1,800</u>
	12,600	6,100	2,400	21,000
	60%	29%	11%	
Total	74,000	35,500	24,500	134,000
	55%	27%	18%	
	21,900	18,500	7,400	47,800

Source: The DPA Group Inc. and J. Anderson.

As shown in the exhibit, existing and unfulfilled (or latent) demand in North America for fresh/frozen salmon is estimated to be 134,000 tonnes. When unfulfilled demand is included with existing demand, restaurants still represent the largest market segment. However, the percentage sold in restaurants decreases from 60% to 55%. The percentage sold in grocery supermarkets increases from 20% to 27%. The percentage sold in fish markets decreases from 20% to 18%.

3.3 Summary and Implications of Demand Projections

There appears to be considerable scope to increase consumption of fresh and frozen salmon in North America without dramatic shifts in determinants of demand such as prices or preferences. The analysis presented above suggests that potential demand for fresh/frozen salmon could increase by more than 50% if supply of preferred salmon products were consistently available.

It also implies that restaurants will remain a large, important market outlet for fresh salmon. Although the expected growth rate in the grocery/supermarket sector is by far the largest, it presently handles only 20% of demand.

Further implications of these results on the overall demand/supply balance, prices, and the design of strategies are discussed in later sections.

FOOTNOTES

1. The components used to estimate aggregate demand using Anderson's sample results are shown below.

Current demand by segment (New England)	X	Adjusted No. establishments by segment in each state	X	Adjustment factor for variations in regional per capita consumption	=	Aggregate Demand
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The current demand by segment was derived from Anderson's survey of buyers (see Appendix A). Weekly demand adjusted for demand differences in summer and winter by segment was multiplied by 52 to estimate annual demand. The number of establishments by sector in each state was determined from the 1986 edition of American Business List Inc. This publication contains current yellow page listings of the total number of establishments by state and province. An adjustment was

made to the food store totals: only one-third of the total food stores was assumed to be grocery supermarkets, which effectively eliminated food convenience stores. An adjustment was also made to restaurant totals to capture those most likely to use salmon. Based on Anderson's New England sample, only 32% of all restaurants had salmon on their menus. (The remainder were fast food/coffee shops, ethnic restaurants, bars, or firms out of business.)

An adjustment factor for variations in regional per capita consumption of finfish was included in the calculation because per capita fish consumption in New England is higher than in other regions. The most recent national fish consumption survey conducted in the U.S. by the National Marine Fisheries Service was used.

5.0 PROJECTED SUPPLIES OF FARMED SALMON IN NORTH AMERICA

This section estimates the production for B.C. and competing regions during the next five years. The expected overall supply/demand balance and the expected impact on prices are also discussed.

Worldwide farmed salmon production is increasing rapidly. As shown in Exhibit 5.1, farmed salmon production increased by 94% from 1983 to 1986. The distribution of U.S. imports by country of origin and port of entry for 1985 and 1986 is shown in Exhibit 5.2.

EXHIBIT 5.1: FARMED SALMON PRODUCTION 1983-1986 (TONNES)

	1983	1984	1985	1986
Atlantic Salmon				
Norway	17,016	22,196	28,656	38,000
Scotland	2,536	3,912	6,921	9,700
Ireland	256	340	700	1,500
Faroes	160	300	500	1,200
Other European	190	250	400	1,100
North American	<u>180</u>	<u>250</u>	<u>300</u>	<u>1,000</u>
	20,338	27,248	37,477	52,500
Pacific Salmon				
B.C.	125	107	120	1,000
Chile	250	530	870	1,000
New Zealand	10	20	500	500
U.S.	833	1,176	1,257	1,500
Japan	2,760	5,049	6,990	7,200
France	<u>80</u>	<u>100</u>	<u>100</u>	<u>-</u>
	4,058	6,982	9,837	11,300
Total	24,396	34,230	47,314	63,800

Sources: Norwegian Fish Farmers' Association, Irish Sea Fisheries Board, B.C. Ministry of Agriculture and Fisheries, Canadian Embassy in Tokyo, and others.

EXHIBIT 5.2: U.S. IMPORTS OF FRESH WILD AND FARMED SALMON^a, BY PORT OF ENTRY, 1985

		<u>Canada</u>	<u>Norway</u>	<u>United Kingdom</u>	<u>Ireland</u>	<u>Chile</u>	<u>New Zealand</u>	<u>Other Countries</u>	<u>TOTAL</u>
Boston	M.T.	2.33	1,422.98	189.98	3.82	-	-	20.22	1,639.23
	% of Total	0.15	22.74	48.26	25.69	-	-	5.50	18.76
New York City	M.T.	2.74	3,157.98	13.95	3.42	47.04	-	81.26	3,306.39
	% of Total	0.19	50.47	3.54	23.00	32.53	-	22.09	37.84
Los Angeles	M.T.	16.68	731.80	1.94	3.74	42.89	57.39	82.08	936.52
	% of Total	1.14	11.70	0.49	25.15	29.66	58.64	22.32	10.72
San Francisco	M.T.	1.92	554.12	4.69	-	-	13.91	11.59	586.23
	% of Total	0.13	8.86	1.19	-	-	14.21	3.15	6.71
Seattle	M.T.	1,329.50	94.77	2.43	-	47.72	26.57	10.80	1,511.79
	% of Total	90.97	1.51	0.62	-	33.00	27.15	2.94	17.30
Washington, D.C.	M.T.	-	130.25	81.01	-	-	-	0.69	211.95
	% of Total	-	2.08	20.58	-	-	-	0.19	2.43
Chicago	M.T.	-	24.94	4.03	2.84	-	-	25.56	57.37
	% of Total	-	0.40	1.02	19.10	-	-	6.95	0.66
Miami	M.T.	-	51.83	2.28	-	3.02	-	0.10	57.23
	% of Total	-	0.83	0.58	-	2.09	-	0.03	0.66
Other Ports	M.T.	108.40	88.49	93.32	1.05	3.92	-	135.51	430.69
	% of Total	7.42	1.41	23.71	7.06	2.71	-	36.84	4.93
TOTAL	M.T.	1,461.47	6,257.16	393.63	14.87	144.59	97.87	367.81	8,737.40
	% of Total	16.73	71.61	4.51	0.17	1.65	1.12	4.21	100.00

^a Excludes fresh fish fillets

Source: U.S. Department of Commerce, Washington, D.C.

British Columbia

The B.C. Salmon Farmers Association forecasts production of about 10,000 tonnes in 1988/89. Based on the proportion of eggs by species distributed to the industry in 1986 and interviews with producers, a breakdown of the estimated production by species and size was derived and is shown in Exhibit 5.3.

EXHIBIT 5.3: ESTIMATED BC FARMED SALMON PRODUCTION IN 1988/89¹
(TONNES)

Size (lbs)	Coho	Chinook	Atlantic	Trout	Total Production	% of Total
Pan size	500	-	-	-	500	4%
2-4	1,500	500	-	500	2,500	22%
4-6	1,750	1,250	250	500	3,750	33%
6-9	1,750	1,750	250	-	3,750	32%
9+	-	1,000	-	-	1,000	9%
Total	5,500	4,500	500	1,000	11,500	100%
% of Total Production	48%	34%	4%	9%	100%	

¹ Production is shown in live weight equivalents.

Source: The DPA Group Inc.

As indicated, nearly one-half of total production is likely to be coho. Chinook should comprise nearly 40% of the industry's production based on a declared surplus availability of chinook eggs from DFO hatcheries in 1986.

Norway

Norway has the world's largest farmed salmon industry, producing nearly 80% of all farmed Atlantic salmon. Production has increased from 100 tonnes in 1971 to 38,000 tonnes in 1986. In 1985, nearly 600 licensed fish farms were in operation. Production is forecast to increase to 30,000 tonnes by 1990. The industry is dominated by small independent farms because of government restrictions on size and ownership. A strong producers association has, among

EXHIBIT 5.2a: U.S. IMPORTS OF FRESH WILD AND FARMED SALMON^a, BY PORT OF ENTRY, 1986

		<u>Canada</u>	<u>Norway</u>	<u>United Kingdom</u>	<u>Ireland</u>	<u>Chile</u>	<u>New Zealand</u>	<u>Other Countries</u>	<u>TOTAL</u>
Boston	M.T.	4.39	2,196.50	169.89	9.41	8.79	1.64	34.35	2,424.97
	% of Total	0.18	24.81	46.33	45.39	1.29	1.02	9.59	18.77
New York City	M.T.	0.39	4,462.73	41.46	0.31	179.30	5.16	108.87	4,798.22
	% of Total	-	50.41	11.31	1.50	26.39	3.21	30.39	37.14
Los Angeles	M.T.	22.37	900.49	12.12	0.26	265.03	86.76	95.45	1,382.48
	% of Total	0.90	10.17	3.31	1.25	39.01	53.96	26.65	10.70
San Francisco	M.T.	8.74	464.80	3.68	-	42.28	16.78	38.07	574.35
	% of Total	0.35	5.25	1.00	-	6.22	10.44	10.63	4.45
Seattle	M.T.	2,244.66	94.45	2.13	-	104.94	50.46	7.58	2,504.22
	% of Total	90.52	1.07	0.58	-	15.45	31.38	2.12	19.39
Washington, D.C.	M.T.	-	219.42	43.57	-	-	-	2.71	265.70
	% of Total	-	2.48	11.88	-	-	-	0.76	2.06
Chicago	M.T.	-	104.69	0.62	4.16	16.04	-	43.08	168.59
	% of Total	-	1.18	0.17	20.07	2.36	-	12.03	1.31
Miami	M.T.	1.01	151.74	-	-	60.93	-	4.17	217.85
	% of Total	-	1.71	-	-	8.97	-	1.16	1.69
Other Ports	M.T.	198.19	257.96	93.19	6.59	2.09	-	23.92	581.88
	% of Total	7.79	2.91	75.42	31.79	0.31	-	6.68	4.50
TOTAL	M.T.	2,479.75	8,852.78	366.66	20.73	679.40	160.80	358.20	12,918.26
	% of Total	19.20	68.53	2.84	0.16	5.25	1.24	2.77	100.00

^a Excludes fresh fish fillets

Source: U.S. Department of Commerce, Washington, D.C.

other things, established quality control and grading standards, set minimum prices for farmers, licensed exporters, and promoted sales.

The proportion of production in 1985 in various size categories are shown in Exhibit 5.4. As indicated in the exhibit, the highest proportion is in the 2-3 kilogram size class.

EXHIBIT 5.4: PROPORTION OF NORWEGIAN PRODUCTION IN 1985 IN VARIOUS SIZE CATEGORIES

<u>Size range</u> Kg	<u>Proportion</u> %
0-1	8
1-2	20
2-3	32
3-4	20
4-5	10
5-6	4
6+	6
	<u>100%</u>

Source: Norwegian Fish Farmers Sales Organization

In 1985, about 90% of farmed salmon production was exported from Norway. Most exports were to France and other European countries. Approximately 24% of export sales were to the U.S. Markets in Europe are expected to remain the largest during the next five years, followed by the U.S. and Japan.

In order to sell the substantial increase in production forecast to 1990, Norway will have to develop an aggressive marketing strategy with traditional customers and in new market areas. This will probably include more marketing directed at retail outlets, improved packaging and advertising, and added-value processing. Increased concentration will probably occur at the exporter level and more influence over foreign distribution will be sought. In addition, Norwegians hope to maintain a technological edge over other producing regions.

Several constraints may limit this growth potential. The limit on the size of farms may actually result in farms producing at sub-optimal levels from a cost minimization perspective. This could put them at a disadvantage in the long term.

Increased exports to the U.S. will result in increased vulnerability to currency fluctuations. As a non-member of the EEC, Norway could also face high tariff rates for exports to Europe. Pollution from aquaculture is becoming more of a problem in Norway and may result in increased disease problems. Lack of capacity in commercial airlines serving the U.S. and Japan may require planes to be chartered. This would result in increased transportation costs, which already average between \$1.75 and \$2.00 per kilogram to Boston or New York. Maximum current capacity on commercial airlines from Norway is 15,000 tonnes to the U.S. and 6,000 tonnes to Japan.

United Kingdom

Farmed Atlantic salmon production in the U.K. is concentrated in Scotland. Although the industry began at about the same time as Norway's, production has not grown as quickly, rising from 600 tonnes in 1980 to nearly 9,700 tonnes in 1986. Projected production in 1990 is 25,000 tonnes. Fifty-seven companies reported production in 1984, but five companies produced 66% of total production in 1984. The larger companies are either part of conglomerate multi-national companies or have Norwegian investment. Combined hatchery and grow-out sites are the predominant form of vertical integration. Salmon farming companies are not heavily involved in downstream fish processing. Most members in the industry belong to the Scottish Salmon Growers Association. The association has developed voluntary quality control and grading standards and is active in the promotion of Scottish farmed salmon.

Most production is consumed within the U.K. About 25% is exported. At present, major export markets are continental Europe and the U.S. These markets are expected to increase in importance during the next five years. The Scottish industry is more advanced than other areas in packaging farmed salmon in consumer-sized packages. As a result, it may possibly have more success than other competitors in penetrating the grocery supermarket segments in the U.S.

Chile

Production of farmed salmon in Chile has been mostly coho, and is concentrated near Puerto Montt in the southern third of Chile. Production in 1986 from nine sites was nearly 1,000 tonnes, a four-fold increase over 1983 production. Eleven companies operate nine hatcheries and 15 cage sites. Companies are mostly large and four are owned by commercial fish processors. Nichino, a large Japanese fish processing company, has an interest in one farm. Another farm, producing Atlantic salmon, has Norwegian backing. Ocean ranching of coho has also begun in Chile. Projected production in 1990 from pen reared and ocean ranching operations is 3,500 tonnes.

Almost all production will probably be sold in the U.S. At present there is no producers association or joint marketing efforts, but both will probably be established in the near future. Growing conditions in Chile are similar to B.C.'s, if not slightly better. However, the industry is less capital intensive. Operating costs are also considerably lower than in B.C., particularly labour. In addition, the value of the peso relative to the Canadian and other currencies has decreased considerably in recent years. As a result of these factors, the Chileans will probably be able to underprice other competition.

The constraints the industry faces are transportation disadvantages from Puerto Montt, reliance on egg supplies from Oregon and Washington, and a short selling season.

New Zealand

Chinook salmon farming has recently been introduced in New Zealand. Eight farms produced about 500 tonnes in 1986. Ocean ranching has also begun. Projected production by 1990 is 3,000 tonnes.

Producers recently formed an association which has developed quality control and grading standards. Sales to date have been mostly to the U.S. and Japan.

The main disadvantage the industry faces is high transportation costs due to its remote location. However, its ocean ranching activities may result in lower production costs than B.C.'s farming industry because there is no high seas interception of its releases. Ocean ranching is essentially a wild fishery. Production from it will therefore be mostly inflexible from a timing perspective.

New Brunswick

Atlantic salmon production in New Brunswick was 180 tonnes in 1985. Ten companies operate in the St. Andrews area in the Bay of Fundy, including a joint venture between Sea Farm and Canada Packers. Connor Brothers, a major commercial fish processor, has recently constructed a grow-out site, in addition to a hatchery and fish feed plant. The company is reportedly entering contract farming arrangements with some smaller firms. Projected production in 1990 is estimated at over 4,000 tonnes.

A producers' association does not exist, but is yet to be involved in marketing. Six companies have formed a marketing co-operative under the name Atlantic Silver. Target markets to date have been Central Canada and the U.S. Eastern Seaboard.

One production constraint is the risk of lethal water temperatures in winter, particularly outside of the Bay of Fundy. As a result, future production in the Maritimes will probably be restricted to the Fundy area.

United States

On the west coast, production is dominated by one large Washington producer of pan-sized coho, Domsea Farms Inc., which is owned by the Campbell Soup Co. This company annually produces in excess of 1,000 tonnes. A few, small, pan-sized coho producers also operate in Washington. Atlantic salmon is also being raised by a Norwegian backed firm in the San Juan Islands. Projected production in 1990 is 2,000 tonnes.

On the East Coast there were seven active farms in the early part of 1987. The most established of these was Ocean Products Inc. (OPI) near Eastport, Maine. OPI production from sea pens in 1986 was approximately 100 tonnes, which represented about 90% of total production. Active farms include two recently constructed land-based systems located in Maine. These facilities will produce mostly Atlantic salmon with some coho production. An ocean ranching operation is also reportedly underway. Two major processors have invested in farms and two other farms have minority interests from Norway. Projected production from the region in 1990 is estimated to be 2,000 tonnes.

All U.S. production will probably be sold in domestic markets. Co-operative marketing is not likely. Production on both coasts is restricted because of availability of suitable sites and conflicts with recreational and other users.

Ireland

Ireland's fish farming industry has been producing since 1977. Production has increased from 21 tonnes in 1980 to 722 tonnes in 1985 from 12 farms. Forecasted output by 1990 is 10,000 tonnes. The structure of the industry is similar to Scotland's. Norwegian investment in the industry has occurred. For example, Mowi AS has an interest in the largest fish farm, Fanad Sea Fisheries Ltd.

The Irish industry is represented by the Irish Sea Fisheries Board. Quality control and grading standards have yet to be adopted by the industry. Only limited generic promotion activities have been undertaken, although Ireland is moving toward programs similar to Scotland's.

Ireland exported about 15 tonnes of salmon to the U.S. in 1985. Exports are expected to increase considerably during the next five years.

Summary of World Production and Supply to the U.S. Market

Projected production of farmed salmon in 1990, shown in Exhibit 5.5, is expected to increase to over 185,000 tonnes in 1990, more than double the 1986 estimate. Norway is expected to remain the dominant producer, but significant production is forecast for other regions, particularly Scotland, B.C. and Chile. Production of Pacific farmed salmon is projected to increase from 14% of world farmed salmon production in 1985 to 27% in 1990.

The production forecasts indicate that farmed salmon will increasingly dominate the fresh salmon market worldwide.

Farmed salmon production in 1985 was approximately 5% of total salmon production. Since the wild salmon fishery is not expected to increase significantly, farmed salmon production could by 1990 represent about 15% of worldwide

output. Salmon farming is also likely feasible in other areas such as South-east Alaska. Therefore farmed salmon production may even exceed the estimates shown above.

**EXHIBIT 5.5: PROJECTIONS FOR FARMED SALMON PRODUCTION 1987-1990
(TONNES)**

	1987	1988	1989	1990
Atlantic Salmon				
Norway	50,000	65,000	75,000	100,000
Scotland	14,000	20,000	22,000	25,000
Ireland	2,200	4,500	6,600	10,000
Faroes	2,000	4,000	5,000	6,000
Other European	500	2,000	3,000	4,000
North American	<u>2,000</u>	<u>3,000</u>	<u>4,000</u>	<u>5,000</u>
	70,700	98,000	115,000	150,000
Pacific Salmon				
B.C.	2,500	10,000	13,000	16,000
Chile	1,500	2,500	3,000	3,500
New Zealand	1,500	2,000	2,500	3,000
U.S.	2,000	2,500	3,500	4,000
Japan	<u>6,000</u>	<u>7,000</u>	<u>8,000</u>	<u>9,000</u>
	13,500	24,000	30,000	35,500
Total	84,200	122,500	145,600	185,500

Sources: Norwegian Fish Farmers' Association, Irish Sea Fisheries Board, B.C. Ministry of Agriculture and Fisheries, Canadian Embassy in Tokyo, and others.

Of particular importance to the B.C. industry is that the U.S. will probably become the most competitive market for fresh salmon within a short period. By 1990, the supply of farmed salmon in the U.S. is projected to be approximately 49,400 tonnes, as shown in Exhibit 5.6.

Supply/Demand Balance and Impact on Prices

The total supply of fresh/frozen salmon in the U.S. to 1990 is projected in Exhibit 5.7. No increases over 1985 levels for wild catches and no shift in product mix are assumed. This was considered realistic since 1985 catch levels were high and are not likely to be exceeded by any significant degree during the next five years.

Total supply of fresh/frozen salmon in the U.S. is projected to be about 109,000 tonnes which is similar to our estimate of existing and unfulfilled demand developed in Section 3.0.

EXHIBIT 5.6: PROJECTED SUPPLIES OF FARMED SALMON TO THE U.S. MARKET

Producing Area	Exports to the U.S. (tonnes)				% of Production
	1987	1988	1989	1990	
Norway	10,000	13,000	15,000	20,000	20%
B.C.	2,300	7,500	9,800	12,000	75%
U.S.	2,000	2,500	3,500	4,000	100%
Chile	1,400	2,300	2,600	3,100	90%
Scotland	2,100	3,000	3,300	3,800	15%
Ireland	300	700	1,000	1,500	15%
New Zealand	1,000	1,300	1,700	2,000	66%
Atlantic Canada	1,000	1,300	1,700	2,000	66%
Others	400	600	800	1,000	N/A
Total	20,500	32,200	39,400	49,400	

Source: The DPA Group Inc.

EXHIBIT 5.7: PROJECTED SUPPLY OF FRESH/FROZEN SALMON 1987-1990 IN THE U.S. (tonnes)

	Farmed	Wild	Total Supply
1987	20,500	60,000	80,500
1988	32,200	60,000	92,200
1989	39,400	60,000	99,400
1990	49,400	60,000	109,400

Source: The DPA Group Inc.

This result suggests that the forecasted supply of salmon to the U.S. market until 1990 could be absorbed by the market at current prices, provided no supply and distribution constraints existed. (Our estimate of potential demand assumes salmon supplies were 'perfectly' available, i.e., a supply of quality salmon was continuously available to existing consumers throughout North America.)

In reality, average real prices for farmed salmon likely will continue to decline until 1990 but not greater than 25-30% below current prices.

There are a number of factors which are creating downward pressure on farmed salmon prices. Production efficiencies in regions like Norway and Chile are improving, and increasing competition is forcing producers to reduce the fairly healthy profit margins they have enjoyed to date. For example, average prices dropped approximately 15% in Europe between 1985 and 1986.

There will be inevitable lags in the growth of distribution capabilities and consumption as marketers in North America work to open up new market segments and territories for farmed salmon. Price declines will intensify if all production is directed at existing market segments for farmed salmon in large, urban centres. Already, evidence of saturation in some markets (e.g. expensive seafood restaurants in the mid-Atlantic region) is occurring at certain times of the year.

Finally, the increase in the available sources of supply could increase the market "power" of major U.S. distributors. Brokers and wholesalers will be able to buy farmed salmon from as many as ten regions. The position of the Norwegians as price setters will be more tenuous as a result. Increasingly, distributors will play one source of supply against another in order to bid down prices.

In the face of these downward pressures, there are a number of factors which could counter the extent of expected price declines, and create a strong floor price for fresh salmon. The principal factor is the continued forecasted shortages of most other wild fish species that are potential substitutes for fresh salmon.

Fresh swordfish, halibut, flounder, and tuna are currently forecasted to remain in short supply. This has led to a significant upsurge in prices for these species over the last 18 months. All of these species currently sell for over eight dollars per pound at the retail level in the Eastern U.S., for example. Fresh cod fillets have even attained prices of close to five dollars per pound in fish shops. Continued supply shortages of these substitutes in the face of rising overall demand for seafood will help to maintain a high floor price for fresh farmed salmon.

Some industry observers point to continuity of supply advantages of farmed salmon as another factor which will both open up new retail markets and help to maintain price levels. Once the industry is capable of continuously supplying large weekly volumes of fish, new retail chain markets will open up which will help absorb the large forecasted increases in supply to the U.S.

In summary, current prices in the U.S. for farmed salmon will likely constitute the ceiling for expected prices until 1990. Some continued decline in prices can be expected, but the prices of other fresh fish substitutes should create a strong floor because farmed salmon currently sells for higher prices than most other species.