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January 10, 1989

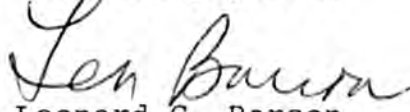
Ms. Sheila Peterson
Office of Senator Dick Eliason
P. O. Box V
Juneau, AK 99811

RE: Salmon Net Pens

Dear Ms. Peterson:

Enclosed is a set of materials provided by Svein Mehli regarding Norway's experience with salmon net projects, as well as proposals to regulate net pens. Please do not hesitate to contact me if you have any questions, or if there is any additional information I can provide.

Very truly yours,


Leonard C. Barson

LLB:pc
Enclosures

**LENKA - A NATION-WIDE ANALYSIS OF THE SUITABILITY OF THE
NORWEGIAN COAST AND WATERCOURSES FOR AQUACULTURE.
A COASTAL ZONE MANAGEMENT PROGRAM**

by

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ABSTRACT

A coastal zone management program called LENKA was started in 1987 and is to be terminated in 1989. The aim is to make an efficient and standardized tool for coastal zone planning, which, pertaining to law, is the responsibility of the county and municipality. The program aims to be beneficial for both the environment and for the fish farmers. Consideration is taken to all important existing utilization and judicial aspects connected to the Norwegian coastal waters. This is done by a systematic collection of all available data, systemized in such a way that they are available for future planning.

A model for the evaluation of the holding capacity primarily for cage culture based on both oceanographical and topographical criteria is put forth. The coast is divided into three categories of recipient based on topography. A central clue in this model is the evaluation of indices for the quantity of aquacultural activities (measured as organic deposits into the recipient) one may have per square kilometer in differently categorized recipients.

INTRODUCTION

Aquaculture in Norway is based on salmon and rainbow trout. The growth of the industry has been rapid, with an almost two fold production increase every second year. The total production this year is expected to be about 80 000 metric tonnes, but the continued growth is expected to be slower. Up to now, the limitation has mainly been on the number of smolts available, this situation is now reversed, partly due to the liberation of smolt production permits.

There is a keen interest in the potential of cultivating marine species, especially halibut and cod. Much effort is put into solving the problems of the rearing of juveniles, and this seems to be solved for cod and turbot. Other species of interest are arctic char, wolf fish, eel and lump fish. Some shellfish are being cultured, mostly blue mussels and oysters, in addition to experiments on scallops. Also and some experiments on ranching of lobster is being performed.

The main asset in Norway for this rapid growth in the aquaculture industry has been the access to vast amounts of water of good quality, both fresh water and salt water. Space and water quality was not a limiting factor to begin with, but is becoming so now. So far, the only measurement available in the assessment of holding capacity, is the amounts of organic waste from mariculture.

There is a need for a planning tool, consisting of directions and knowledge, to aid the development in such a way so that a high productivity is maintained at the same time as conflicts with fisheries, conservation interests, leisure activities and other utilization is kept low. The tool will have to be standardized and rational.

Both county and local municipality have the need for a plan on how to utilize the marine resources. The county plan is a guiding one, the judicial binding is not persistent before there exists a plan approved of by the local municipality.

This paper, written by the expert group on marine environment, presents the biological and oceanographical aspects of the project.

This is a description of an ongoing project where the guidelines are not yet completed. As we believe that there is a considerable interest in these matters, we find it appropriate to give some information on the project at its present state.

THE PROJECT

The project is a cooperation of three ministries, the Ministry of Fisheries, the Ministry of Environment and the Ministry of Local Government and Labour. Its name LENKA is a Norwegian abbreviation meaning: A Nation-wide Analysis of the Suitability of the Norwegian Coast and Watercourses for Aquaculture.

The project aims to :

- * To contribute to a continue positive development and growth of the aquaculture industry with minimal conflicts with other utilizational and conservational interests.
- * To contribute to the county and municipality planning in the coastal areas and watercourses.
- * To contribute to the siting process of aquacultural activities.

The project is a planning tool, and not a plan in itself. Further, it does not aim at the site as a working level, but handles larger areas as the base unit, later referred to as LENKA zones.

Project organization :

Figure 1 gives a schematic picture of the project organization.

The development of the working methods is done by the three expert groups and the secretariat at the Ministry of Environment, while the gathering of data, map work etc, is to be performed by the county project organizations. The three expert groups are placed at the institutions with the relevant competence. The group working with watercourses

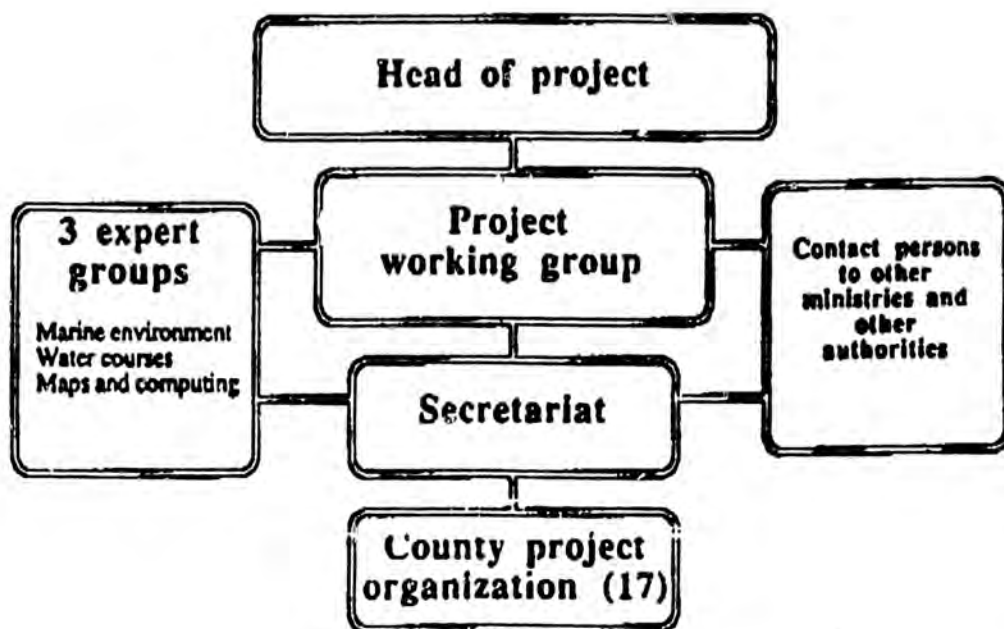


Figure 1: The LENKA - project organization. The head of the project consists of the Secretaries General from the Ministries of Fisheries and Environment. The project Working group has 3 members from the Ministry of Fisheries, 3 from the Ministry of Environment and 1 member from the Ministry of Local Government and Labour. The Secretariat is placed at the Ministry of Environment.

is placed at the Directorate for Nature Management, Trondheim. The group working with maps and computing is placed at the Norwegian Hydrographic Service, Stavanger. The two latter's part of the project will not be presented in this paper.

The group working with the aspects concerning the marine environment is placed at the Institute of Marine Research, Bergen. In addition, the group also has members from other institutions, such as the County Environmental Protection Department, the Ministry of Environment and Nordland College, Bodo.

The project has a total cost of 40 million NOK spread over three years.

THE MAIN WORKING PROCEDURE

The main working procedure of the project is shown in figure 2 (next page).

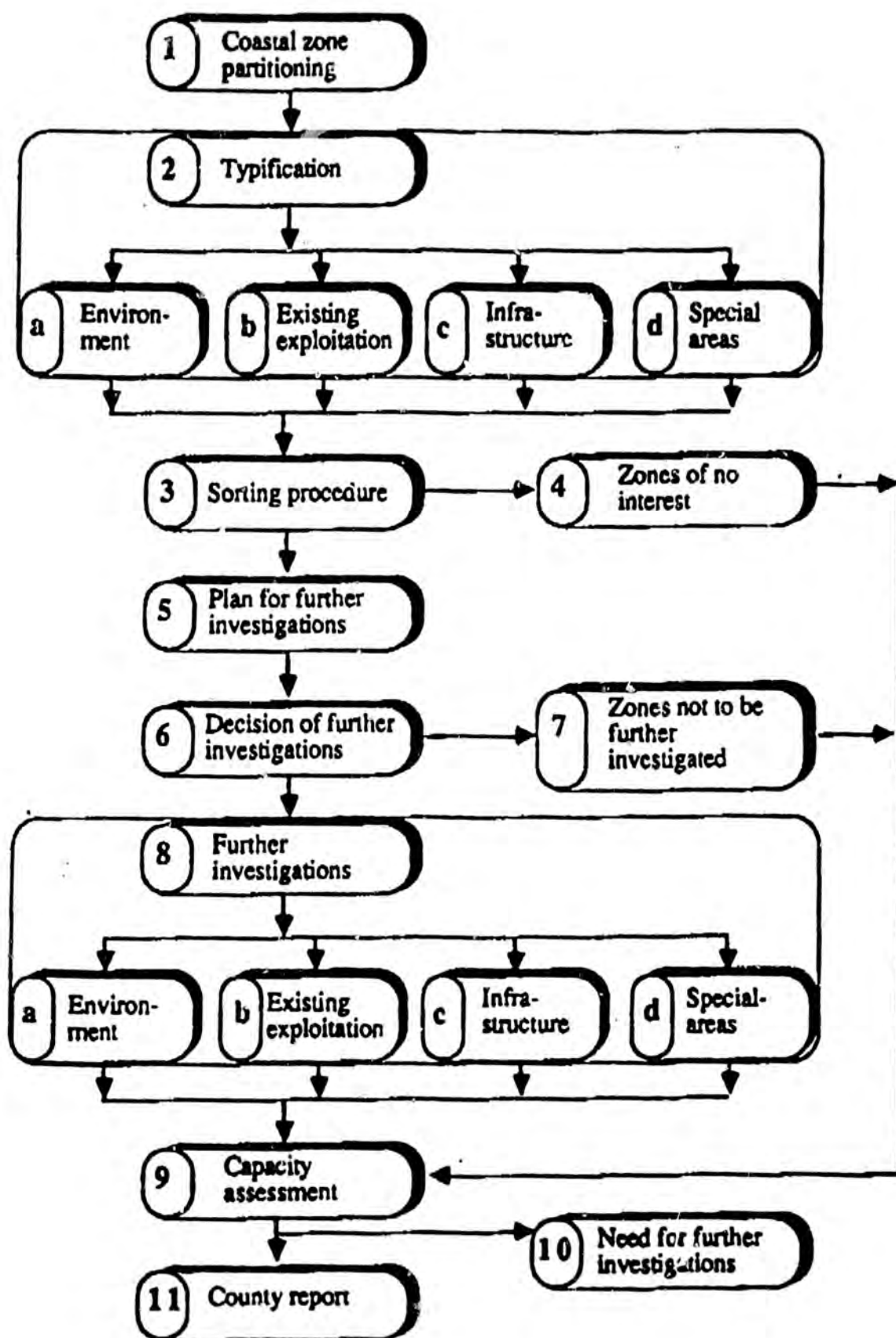


Figure 2 : The main working procedure of the LENKA - project.

ZONE PARTITIONING

In order to be able to deal with our 57 000 km long coast line in portions of manageable size, a partitioning is necessary. The principle of the partitioning is that each major water volume should be handled separately. Roughly, the coastal zone is divided into smaller areas (LENKA-zones) each being either an archipelago, a fjord, a large sound or an open fjord basin. The smaller areas will reflect the water bodies capacity to handle the organic loadings received from both aquaculture and other sources.

In order to separate the water volumes, the borders should to a large extent as possible follow land. An example of how this looks like is shown in appendix 1, where the partitioning of County Hordaland (where Bergen is situated) is shown.

TYPIFICATION

Typification of zones is a registration of the environmental properties of the area. In this project the aim is to collect and systemize the data that already exist. For some parameters the data will be scarce. This is taken into consideration, and follows the description of the area. The compiled information will be transferred to maps, the result being a visualized presentation of the environmental properties of the marine environment. Similarly, this is done for the other three main groups of parameters, Existing exploitation, Infrastructure and Special areas.

The following parameters and their significance were used for the typification of the zones. These are the major environmental parameters that have influence on the utilization of the coastal areas for aquaculture. We would like to note that we do not consider any technological devise that frees the farming installment from the marine environment surrounding it. This is mere a question of economy, and will not be considered in this project.

ENVIRONMENTAL PARAMETERS USED FOR TYPIIFICATION OF ZONES :

Pollution :

The point in this connection is that the contamination of the environment affects the health or the marketability of the fish raised in these waters. Also, we distinguish between two categories of pollution: toxins as one kind and organic loadings as another. Most important are the massive outlets from industry and agriculture. Some areas are severely polluted by heavy metals and toxins from specialized industries. In addition there are several smaller sources of various kinds of pollution with a more or less restricted effect on the marine environment.

Temperature :

When considering temperature conditions in Norwegian waters, low temperatures is the main hindrance of aquacultural activities, though there are some problems with too high summer temperatures in some parts of the country. Of interest are the extreme temperatures occurring within a time span of 5 - 6 years (our definition of frequent). Areas reckoned as unsuitable for aquaculture have regular long periods, that is 6 weeks or more, with temperatures below zero centigrade. Measurements ought to be taken at depths of 2 to 5 metres.

Ice cover :

Of interest are the areas covered with ice at least every five years.

Exposure :

The actual parameter here is wave height, though current velocity also is part of the exposure problem. Current in itself only occurs as a problem locally, but infers on the wave height. Suitable areas for cage culture is where the wave height does not exceed 2 m. For wind to generate such a wave height, a stretch of 10 km open water is needed. Here we would like to add that the general development of the aquaculture industry in Norway has been towards more robust cage constructions, with cage systems being able to stand up to wave heights of up to both two and three metres.

Depth conditions :

The depth required under the cages is dependent on the current velocity to ensure that the wastes from the farm is spread. Also this is a way to

avoid possible eruptions of hydrogen sulfide gas from the sediment that often accumulates under the cages to reach the fish in the cages. As a general rule we have set 20 m depth to be a minimum criterion for cage culture, with the possibility of adjustments to current velocity.

Basins :

A basin is a water volume restricted from the outer lying larger water masses by a threshold. A basin is defined as where the depth of the basin is at least 10 m deeper than the threshold. This water volume is sensitive to organic loadings, causing a possible disturbance of the oxygen balance. All thresholds shallower than 50 m have been registered.

Salinity :

The influence of freshwater causes several problems for the fish farms. A layer of brackish water on top of the salt water resulting in a strict stratification, may cause severe fluctuations in salinity and also fluctuations in temperature. As a limit for when the influence of fresh water becomes a problem, we have put the salinity measurement to 25 ppt.

Other main groups of parameters :

Under the heading of existing exploitation we list the followings parameters :

- effects on settlement patterns
- open air recreation life
- port development
- fisheries
- shipping traffic
- other factors .

Further, there is a separate heading called infrastructure, dealing with the particular requirements which should be met for an aquaculture enterprise to succeed. Main parameters are :

- road development
- distribution of manufactured feed
- processing facilities
- health service and guiding service
- offal disposal systems.

The last heading is special areas, conditions that might conflict with

further development of aquacultural activities. Examples here are :

- spawning grounds for important fisheries species
- reserves for coastal birds and marine mammals
- others.

A MODEL FOR CAPACITY ASSESSMENT

Some imperative reservations :

With capacity we mean holding capacity, which is : the maximum production limited by a non trophic resources. Or put in a simpler way, what quantity of aquacultural activity is possible in an area without there being damage caused to the environment. This is measured as deterioration due to organic overloading causing eutrophication, oxygen depletion a.s.o..

This method of capacity assessment of LENKA zones is based on the emphasis of two main considerations :

- 1) the environmental impact from mariculture
- 2) the marine environment's impact on the cultured organism.

It is by no means possible to give exact values on what loadings from mariculture are acceptable, that is, how much organic waste from mariculture is possible without any negative influence on the surrounding environment. Some general recommendations are given in the State Pollution Control Act, the entire aspects are being dealt with by the Ministry of Environment and the State Pollution Control Authority. The total environmental impact from fish farms will manifest themselves several years after the farm has started production.

To be able to assess any capacity for aquaculture, one has to take into consideration the contribution from all major sources of organic loadings.

Elements of the capacity assessment :

Many parameters affect the capacity assessment. Not only the above mentioned parameters are of importance. The LENKA - project takes into consideration the elements shown in figure 3, and the working procedure is shown in figure 4. As is shown, there are two main aspect in the

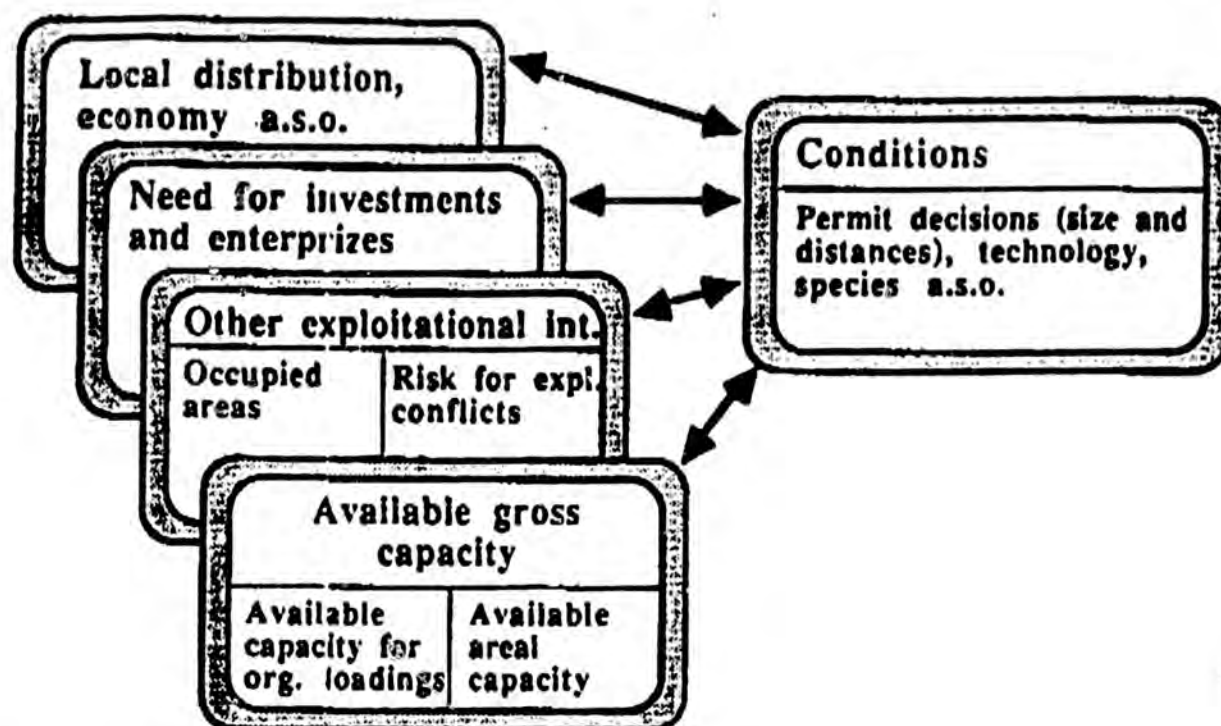


Figure 3 : Elements of the capacity assessment.

capacity assessment. One aspect is the evaluation of the capacity for organic loadings in water body (LENKA zone). This is done by treating the zones properties as a recipient for organic loadings. The other aspect is based on space. The water body, or more precise, parts of it, is occupied by other activities as mentioned earlier. There exists a net area available to aquacultural activities. One of these will set the limit to aquacultural activities.

In our capacity assessment we have based the calculations on organic loadings, and thereby neglected limitations set by factors such as risk for spreading of diseases, use of chemicals and therapeutica etc. There exists a veterinary regulation on distance between farms, this is set to 1 km. Criteria as such may be altered as the knowledge increases.

The recipient capacity :

Classification of coastal areas within the zones :

Classification is based on topography. This again reflects the water exchange regime in the area, as well as being an indicator of the area's

Recipient

Area

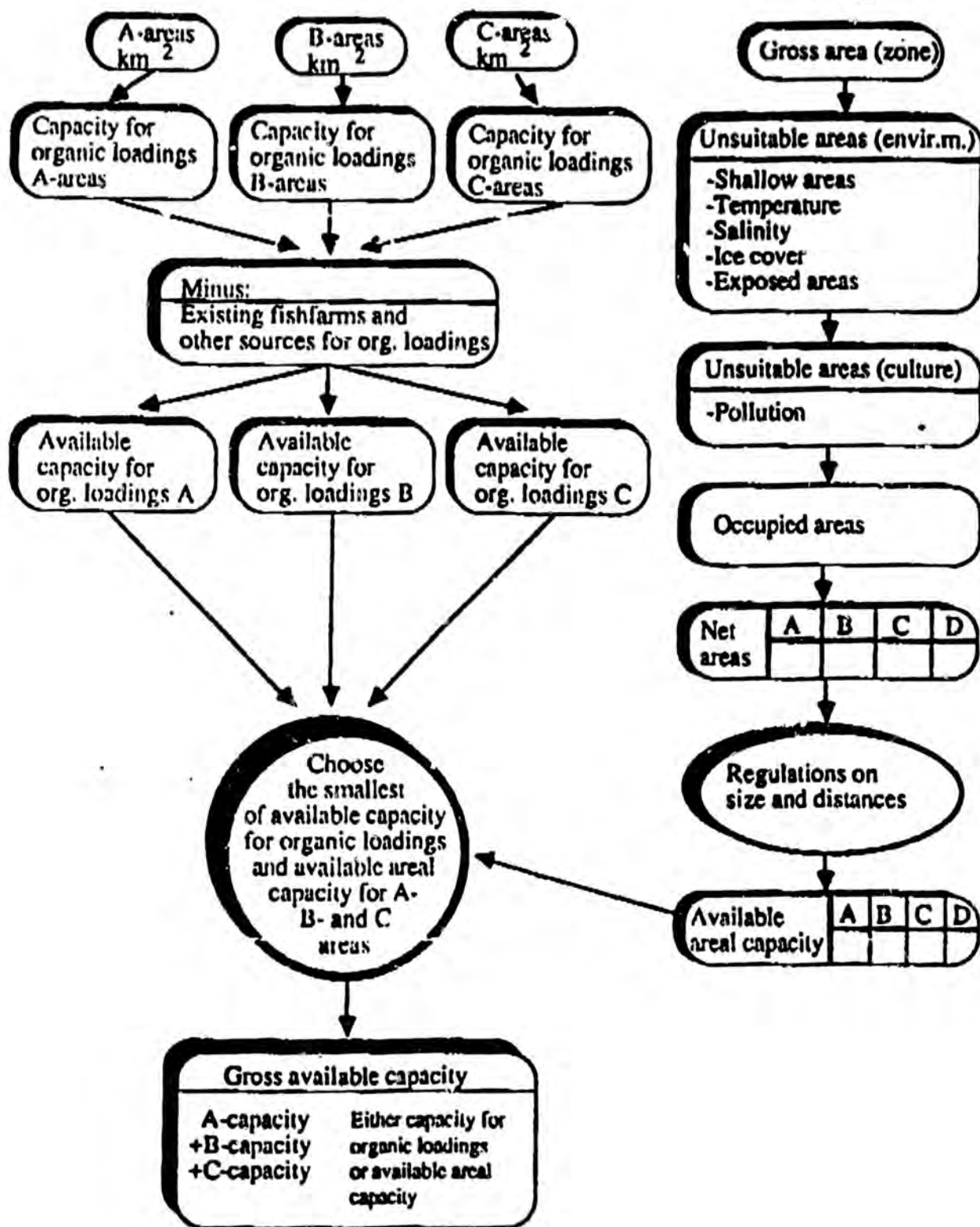


Figure 4 : Calculation of gross available capacity.

property as a recipient. An exact classification with illustrations is given in Appendix 2.

For each recipient category A, B and C there is given an index for how much aquacultural activity is recommended. This is expressed as a certain production in terms of tonnes per square kilometre. Here we would like to emphasize what care was taken before these indices were given. The procedure was as follows :

From empirical data we were able to extract the general statement on how large production one could have in a specific area without it causing damage to the environment. The effects were investigated by sediment fauna monitoring. These levels of production were converted to production per square kilometre. Again, based on facts about Norwegian fish farms, these values were converted to organic loadings, expressed as oxygen consumption, total phosphorous and total nitrogen.

As a correction factor one would have to adjust these figures for other major outlets of organic waste. At the moment we are, together with the appropriate institutions, giving a simplified method for estimating the impact on the marine recipient based on key figures ready available. The capacity is calculated in terms of organic waste, and is therefore independent on the technology being used. New technologies resulting in reduced outlets from the farms can easily be incorporated in the calculations.

Further, when capacity is expressed as production as tonnes per km², this sets restriction to the size of single farms and to the total activity in larger areas. The values are not decided yet, but the capacity will be expressed as the following :

A - categorized areas : a maximum production per (4x4) km², but not more than a lesser specifies quantity at a single site. A site is defined as occupying a minimum of 1 km². Where the recipient conditions are particularly good, and the number of sites available is restricted, one may exceed these recommendations.

B - categorized areas : similarly as above, there is given a maximum production per (4x4) km², and a lesser one at a single site.

The capacity per (4x4) km² will be in the magnitude within one thousand metric tonnes for both A- and B - categorized areas.

C - categorized areas : these areas are basins and silled fjords, and special care should be taken in such areas. Aure & Stigebrandt have developed a model for the calculation of oxygen consumption in silled fjords (Aure and Stigebrandt 1982, Stigebrandt and Aure 1988), and this can in turn be used as a method for the calculation of capacity in terms of organic loadings. The calculations can be done given the hydrographic data and topographical maps.

Where there is oxygen depletion in the basin water, aquacultural activities are not recommended in silled fjords. In basins within archipelagos one should ensure that the water in the deeper layers of the basin does not suffer from oxygen depletion. This means that in an area categorized as a C grade recipient, no aquacultural activities are recommended before one has sufficient data so that damage to the environment is avoided.

This method is dependent on a monitoring and control scheme, and this will have to be a perpetual process. In this way there is the possibility of adjusting the proposed capacity assessment, and at there is possibility of keeping an eye on what is happening to the environment. The monitoring and control schemes are not established.

The areal capacity

Unsuitable areas :

Each LENKA - zone has a gross area divided into A, B and C type recipients. Parts of these areas may be unsuitable for aquaculture, that is, unsuitable for cage culture for as it is practiced in Norway. Unsuitable areas consist of environmentally unfavorable areas from both natural conditions and as a result of man's activities. The last case is mainly pollution, and in this case pollution of toxicants that directly affect the fish health and marketability.

The environmental parameters taken into account are : Shallow areas, cold water, low salinity, ice cover and exposed areas.

In addition to these unsuitable areas there are certain areas that are

bound up by other activities. Such areas are :

- area already occupied by existing aquacultural activities
- nature reserves and animal protection areas (both birds and sea mammals)
- security zones for salmonid fish

In addition areas are occupied for military purposes and for ship navigation.

Having subtracted all these areas, one is left with a net areal capacity which can be compared with the recipient capacity. The smallest of these will set the limit. All these calculations will be performed by computers as all the information is to be tabulated ready for a for this purpose constructed work sheet.

Finally, we would like to mention the work initiated to eliminate the interactions between wild stocks of salmon and trout and farmed fish. The possibility of affecting the genetics and spreading of diseases has been much debated. There is now suggested temporary protection zones for salmonids, with a supporting research program. Further information on this is available on request.

In addition to the names and addresses in the author list, there are a few more names to add. If anybody should have any particular interests, the following persons may be contacted :

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Appendix 1 :

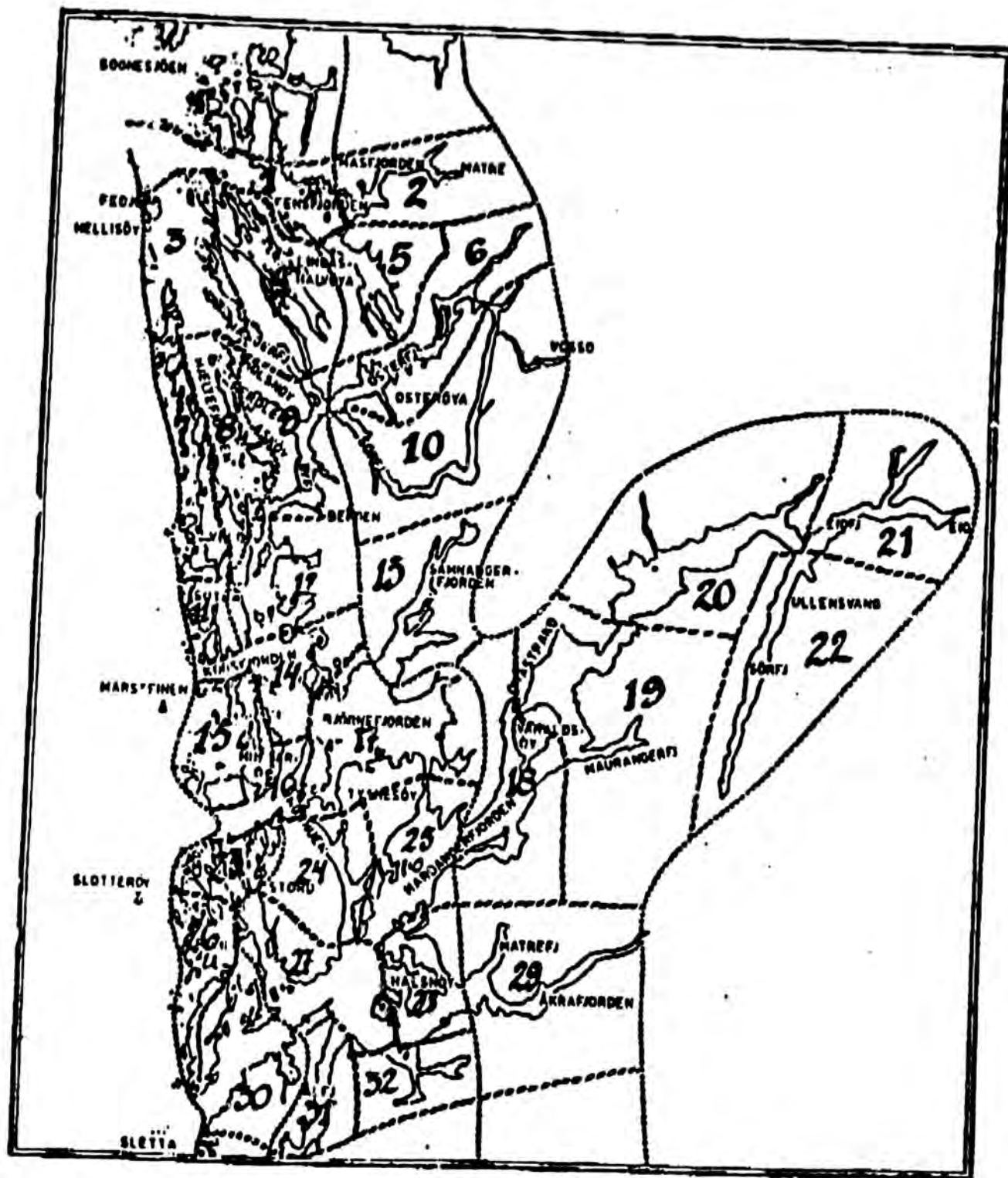


Figure 5 : Example of zone partitioning for the County Hordaland, Western Norway.

Appendix 2 :

Division of the coastal zone into smaller areas based on assumed water exchange rate caused by topography.

A : Open coastal areas and large fjords where depth is larger than 50 m.

A₁ : Open coastal areas where depth is larger than 50 m.
Size and sills are not considered.

A₂ : Large fjords where :
Length of more than 10 km, and
No presence of sills¹⁾.

B : Other areas with good water exchange.

B₁ : Open, sill - free areas as A₁ (archipelagos) and large fjords as A₂ but where largest depth is less than 50 m.
Length above or less than 10 km.
Depth²⁾ is less than 50 m.
No presence of sills.

B₂ : Smaller fjords, bays and inlets where :
Length is less than 10 km.
No presence of sills.
Depth is greater than 50 m.

B₃ : Large, silled fjords³⁾ where :
Length is greater than 10 km.
Presence of sills.
Depth may be more than 50 m.

C : Small silled fjords and other silled areas (archipelagos) :
Length of fjord less than 10 km.
Presence of sills⁴⁾.
Depth may be more than 50 m.

Examples are shown on the sketch on the next page.

¹⁾ : A silled area is defined as an area where the inside basin is at least 10 m deeper than the sill. Sills down to 50 m are registered.

²⁾ : Fjords are reckoned as shallower than 50 m when more than 60 % of the area fulfills this criterion.

³⁾ : Fjords and other areas with several succeeding sills is reckoned as a "new fjord" when the succeeding sill is shallower than the preceding one.

⁴⁾ : In sounds and basins within archipelagos with several sills, the deepest sill is reckoned as the main entrance to the basin.

THE ESTABLISHMENT OF A SALMON SPERM BANK IN NORWAY

Dagfinn Gausen, The Directorate for Nature Management
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Introduction

Extinction of local, indigenous fish stocks and erosion of genetic resources are subjects of growing concern for salmon management in Norway. The primary causes of excess salmon mortality in the present century are acid precipitation and the parasite Gyrodactylus salaris. Approximately 25 stocks are nearly or entirely extinct in southern and western sections of the country, which are heavily affected by acid precipitation (information from county conservation authorities). According to official statistics, an additional 15 stocks are extremely reduced in the same area (Hesthagen & Mejdell-Larsen 1987). Gyrodactylus salaris has spread to 28 watercourses, and in many cases is responsible for enormous fish mortality. The fisheries is estimated to have lost between 250 and 350 tons of fish (Johnsen and Jensen 1985).

Escapes by salmon from fish farming pens in the sea, represent a new, and potentially greater, threat to natural genetic resources. Hybridization between farmed and wild salmon is expected to reduce genetic variation within and between natural stocks. Investigations carried out by fish managers and members of the gene bank project suggest that more than 13% infusion of farmed salmon may already have taken place in the salmon rivers of Southern Norway. A rapid increase in this proportion is anticipated over the next few years, in association with expansion within the salmon farming industry.

With these problems in mind, the Directorate for Nature Management decided to establish of a national sperm bank for wild salmon. This measure was recommended by the Advisory Committee of the Sea Ranching Program and was made financially possible by grants from the Ministry of Environment. The sperm bank project was included in a sea ranching program which was officially begun

by the directorate on January 31, 1986. The aims of the program are to develop better methods and improve our knowledge of how salmon production may be increased, and to preserve local salmon stocks. Genetic aspects of the program involve establishing a sperm bank, population genetic mapping and registration of the genetic and biological effects of introductions. The program is planned for a ten year period. During initial phases, the sperm bank will be based exclusively on deep freezing of sperm, but the program eventually hopes to build up a technical capacity for maintaining salmon stocks over several generations in a so-called "living gene bank".

Objectives and strategy

The main purpose of the sperm bank is to preserve genetic variation. A sperm bank can contribute to nation-wide preservation of genetic variation in natural salmon stocks, between stocks and within specifically designated stocks.

The population genetics of salmon stocks in Norway have not been previously mapped to any great extent. The selection of salmon stocks for storage in a sperm bank must therefore be based on other criteria. Marshall & Brown (1975) discuss sampling problems in cases where genetic variation is unknown, and suggest the following optimal collection strategy for gene banks:

1. 50 - 100 individuals should be collected from each location.
2. Sampling should be carried out at the maximum possible number of locations for a given time period.
3. Sampling locations should represent a wide ecological spectrum.

A somewhat modified form of this same strategy has been employed by the sperm bank project.

1. Sperm from at least 50 individuals from each stock is frozen.

2. Emphasis is placed on sampling from stocks representing a wide geographical and ecological range.
3. Stocks threatened by extinction are given priority over other stocks.
4. Stocks which are of particular scientific value, or valuable for fishing purposes, are given priority.

The last-mentioned point complies with recommendations made by the "Nordic symposium on gene banks and other methods of preserving genetic resources", which was held in Finland in 1978.

Methods

Deep freezing of sperm is a realistic gene bank alternative which today facilitates gene storage over a nearly unlimited period of time (review in Stoss 1983). The following method was applied: Fresh sperm is cooled to temperatures between 0° and 4°C, and a freezing medium comprised of 10% DMSO and 0,3% glucose is added (Stoss & Refstie 1983). The mixture (1 part sperm and 3 parts freezing medium) is formed into pellets using a pasteur pipette and dry ice (-79°C). After three minutes on dry ice, the pellets are cooled in liquid nitrogen to -196°C, and transferred to covered cryo-tubes. The tubes are stored in a large nitrogen container with an internal drawer system.

1,5 millileters of sperm from each fish (120-130 pellets) are frozen and divided among two 5 ml cryo-tubes. The total sperm volume may potentially fertilize 1000 eggs. This sperm is not to be used in ordinary cultivation projects because of limited volume and high expenses involved in collection. The sperm will exclusively be used in the establishment of parent fish populations, and for maintaining genetic variation in a "living sperm bank".

Organization of the sperm bank project

The sperm bank project is administered by personnel associated with the Fish Management Division of the Directorate for Nature

Management. Collection is planned in cooperation with the Environmental Protection Offices of the varying County Administrators. These offices provide advice about potential stocks for inclusion in the sperm bank from each county, and arrange local contacts.

Collection is carried out in close cooperation with local organizations which collect parent fish for use in the cultivation of individual rivers; fishing and hunting associations, land owners associations, salmon boards and hyrdo-power development boards. Staff from the directorate, equipped with a mobile field laboratory, visits localities where parent fish are held. Sperm are frozen at these locations. A special sperm sample for later genetic analysis is taken from each fish. In addition scale samples are taken and all fish are weighed and measured. The permanent sperm bank is located at the breeding station for Norwegian Red Cattle (NRF) in Trondheim. Liquid nitrogen is provided by NRF.

Results and experiences

The sperm bank project was partially a pilot project in 1986. Some of the main objectives were to test methods and equipment, and to discover the most efficient methods for carrying out and organizing the project.

Field work began on October 8, and continued over 46 days. A distance of over 10 000 kilometers was travelled and total expenses amounted to 320 000 Norwegian kroner. Salmon sperm was collected in nine counties from Finnmark to Rogaland, and samples were taken from a total of 371 fish from 47 different stocks. An outline of the material collected is presented in Appendix 1. A comprehensive presentation is given in Figure 1.

In 1987 the work continued following the same guidelines. The project was granted more money permitting the inclusion of one more field-team. After two years in operation the gene bank now contains sperm samples from 857 salmon from 69 stocks.

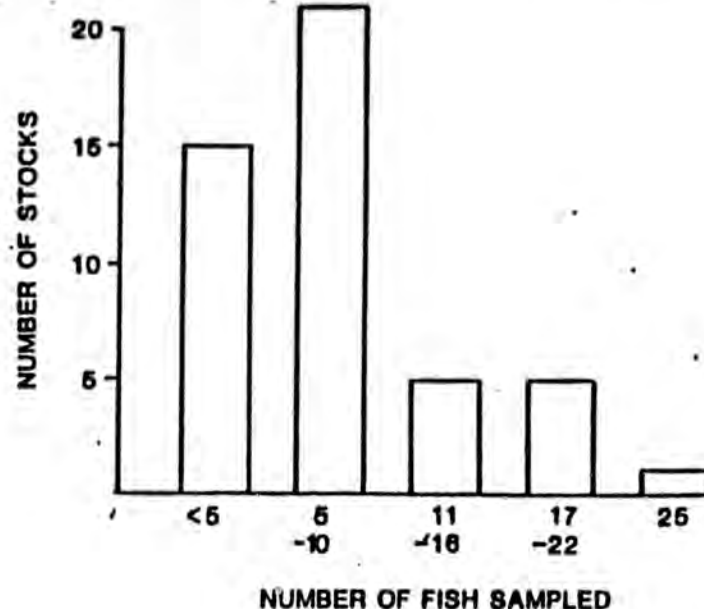


Figure 1. Distribution of stocks with regard to the number of fish sampled.

With few exceptions, sperm freezing was carried out at fish culture stations (parent fish facilities, hatcheries, or smolt facilities where parent fish are held). Only one fish stock is usually held in each facility. An average of eight fish from each stock were sampled. Fish stripping and sperm freezing procedures therefore only slightly influenced the effectiveness of the field work in terms of number of stocks sampled each day. Stock sampling was more often restricted by daily commuting distance and the execution of tasks other than stripping and freezing (preparation of equipment, disinfection, packing and unpacking of equipment, ordering of disposable supplies, and visits to local contacts etc.). Given the above restrictions and a daily commuter distance of over 200 kilometers, a maximum of one stock sampling per day was within the realm of reasonable expectation.

Restricted time was another factor which influenced the total number of samples taken. Samples could only be taken during the interval between the onset of maturation for stripping in male fish and the cessation of sperm production. Male fish may be stripped from the middle of October in most areas of northern Norway, but maturation occurs somewhat later in southern Norway where large variation is found between stocks.

Field work therefor began in the counties of Troms and Finnmark, and proceeded in a southerly direction. Problems encountered because of diminished sperm production began by the end of November. Some fish had already been stripped once for river cultivation purposes and had ceased to continue producing sperm. At the same time problems with increasing male fish mortality occurred at culture stations.

The number of sperm samples from each stock was restricted by the number of male fish at the station. Several factors influence the number of male fish used in the cultivation of individual rivers. However, the most significant limiting factor is potential for catching parent fish. This was extremely difficult when fish stocks were reduced by G. salaris, acid precipitation and other forms for pollution. Collection of sperm from 17 highly endangered stocks was initially planned. Attempts were totally unsuccessful for 6 of these, and less than 5 male fish were caught in a further 6 stocks. Special measures are required in order to insure the inclusion of sperm from many of the most threatened stocks in the sperm bank.

The autumn of 1986 was extremely wet, a factor which complicated fishing for parent fish in many rivers. This increased difficulties in catching parent fish in rivers with threatened stocks, and also caused problems in rivers where fishing is usually good. The relatively large number of stocks represented by few samples (Fig. 1) should be considered in the light of sampling difficulties.

Existing fish cultivation projects in individual rivers are of decisive significance for the success of the sperm bank project. Project expenses would have been astronomical without the assistance of fish culture stations in catching and holding parent fish, which has facilitated the establishment of a nation-wide sperm bank. The extent of fish cultivation activities therefore is a significant factor which may limit the number and selection of stocks included in the sperm bank in the future.

Parent fish collection is carried out in 130 of the 400 salmon-carrying rivers in Norway. Some of these are not potential candi-

dates for the sperm bank. On the other hand a number of high-priority stocks are not cultivated and therefore no milt fish is available. The project undertook the collection and storage of fish from one such stock in 1986. If genetic material from some of the most threatened stocks is to be saved from extinction, activities of this kind should increase.

The practical experience gained through the sperm bank project in 1986 was extremely valuable. Deep freezing methods were adapted to field conditions, and effective work routines were established. A great deal was learned about equipment and staffing requirements, and our experiences should assist the future development and administration of the project.

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APPENDIX I. Localities of salmon stocks included in the sperm bank project in 1986, and the number of fish sampled (N).

<u>County</u>	<u>Locality</u>	<u>N</u>	<u>County</u>	<u>Locality</u>	<u>N</u>
Finnm.	Altaelva	11	Sogn & Fj.	Sogndalselva	5
Troms	Skibotnelva	3	"	Lærdalselva	6
"	Reisaelva	12	Hordaland	Oselva	6
"	Målselva	20	"	Loneelva	15
Nordland	Bleikvassdr.	15	"	Vosso	18
"	Bukksnessvassdr.	5	"	Etneelva	16
"	Ranaelva	20	Rogaland	Vorma	3
"	Røssåga	4	"	Ardalselva	8
"	Vefsna	6	"	Håelva	2
N.Trøndelag	Namsen, nedre	9	"	Suldalslågen	8
"	Namsen, øvre	9	Aust-Agder	Byglandsfjorden	25
"	Sanddøla	8		Neva (USSR)	7
"	Nordelva	3		(Scientific purposes)	
"	Søråa	3			
"	Bjøra	1			
"	Byaelva	1			
"	Ogna	1			
"	Moldeelva	1			
"	Verdalselva	6			
S.Trøndelag	Orkla	4			
"	Gaula	3			
"	Nidelva	5			
"	Stordalselva	9			
Møre & Roms.	Surna	10			
"	Eira	6			
"	Rauma	5			
"	Måna	7			
"	Ørstaelva	18			
"	Bondalselva	17			
"	Bøvra	1			
Sogn & Fj.	Eidselva	7			
"	Stryneelva	9			
"	Hyenvassdr.	4			
"	Jølstra	3			
"	Arøyelva	7			

PROTECTION ZONES FOR SALMONS - A CONCEPT FOR THE
PRESERVATION OF GENETIC DIVERSITY OF WILD SALMONS
AND REDUCTION OF THE SPREADING OF DISEASES BETWEEN
DOMESTIC AND WILD SALMONS

by

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BACKGROUND

Norway has some 500 local populations of wild salmon, each having its particular spawning river. During thousands of years these populations have developed local, genetic, distinct characteristics as regards size, growing speed, behaviour and ecological adaption.

These local populations constitutes a vast genetic recourse, which we, in the line of the recomanditions of the Brundtland commission, believe we are responsible to protect and manage as intact as possible as a resource for the coming generations.

From the Nature Conservation part of view, the protection of genetic diversity is an aim in itself. From the aquacultural industry's point of view, the genetic variations found in wild salmon populations constitutes the biological basis for the future sustainable development of salmon R-94

farming, with particular importance for breeding programmes.

There is therefore a general agreement among the authorities in Norway that the wild salmon populations should be kept healthy and strong, an agreement also of course shared by those who have a commercial or recreational interest in wild salmon fishing.

Let me also for the background mention that the different salmon populations over the years have been severely affected, by acid rain, water course regulations, parasites and overfishing both in the rivers and in the seas.

IMPACT ON WILD SALMON POPULATIONS FROM AQUACULTURE.

During the last years there has been a growing concern in Norway on what effects the growing fish farming industry will cause for the wild salmon populations.

Two main points have come into focus:

1. The breeding programmes have resulted in a domestic salmon, which are genetically significantly different from wild salmons. Surveys in 1987 in 54 rivers in the southern part of Norway shows that out of 615 caught salmons, 83, that is 13%, were escaped salmons from fish farms. The actual figure is probably however much higher. The catches were organized through the Norwegian gene bank project. Catching was done by local co-workers, who were instructed to drop all salmons which could be identified as domestic salmons in the first hand. The 83 salmons in this figure are thus the remaining domestic salmons identified by the experts of the project after the sorting out done in the first hand by local co-

workers.

Because of figures like there is a growing fear that continuous interbreeding between escapees and wild fish will cause a considerable reduction of the natural genetic diversity in salmon populations.

The most alarming and pessimistic prognoses by one the leading experts in Norway on genetics, professor Harald Skjærvold at the Norwegian Agricultural University, anticipates that we may have 50% reduction of the natural genetic variety in the course of a periode of 7 to 10 years. I must add, however, that there are different points of view among norwegian genetic experts, mostly because of uncertainty as regards the spawning success of escapees in competition with the wild salmons.

2. The two-way spreading of diseases between wild fish and fish farms is another problem. The general picture in Norway is that the different fish diseases mainly cause problems for the farms, not the wild populations. The diseases exist in nature and is part of the ecological balance broadly speaking.

As an example of this, the second best salmon river in Norway, the Numedals-lågen was infected by furunculosis in the seventies. But during all the years furunculosis where found in Numedals-lågen it did not have any significant effects on the magnitude of the catches.

But there is one important exeption in this picture, the Gyrodactyllus Salaris, a parasite which now has spread to 30 Norwegian rivers causing death to young salmons in their first three living years in the fresh water periode. The parasite has virtually wiped out the salmon populations in many of those 30 rivers. We believe

that the reasons for these dramatic effects is that the parasite is introduced to norwegian watercourses (it is native to Sweeden and the Baltic sea). Norwegian salmon populations has no "ecological defence" against it. The Gyrodactylus Salaria is spread mainly through the distribution of fry and waters from infected hatcheries.

Let us add that there is a considerable concern in Norway on the long-term effects of the growing pressure of fish-diseases on the environment. The alarming growth in use of antibiotics is one question of particular importance. To day the use of antibiotics in agriculture extends the use in agriculture and human medicine, put together.

A research programmed was therefore startet in 1987 to strengthen the knowledge on long term effects of the use of antibiotics.

THE PROTECTION ZONE CONCEPT.

The concept which was put on the agenda of Lenka by the Ministeries of the Environment and the Fisheries was to see if one could hope to reduce genetic mixing and the two-way spreading of diseases by establishing zones in the fiord areas outside the outlets of the most important salmon rivers where fish farming should be restricted or not allowed at all.

To have a thorough discussion and evaluation of the zone concept, Lenka arranged a meeting in February 1988. Most of the norwegian experts in the field of genetics, fish diseases, and the ecology and behaviour of salmons were participating.

The recommendations from the meeting were in short:

1. The zone concept should be elaborated in detail for a sample of the genetically most important salmon populations by an expert group.
2. Because of the uncertainty on whether the zones will prove to be an efficient measure, zones should be established for a temporary periode of 5 years. After 5 years there should be a evaluation of the effects of the zones.
3. A research programme covering both genetic effects, veterinary research, and the development of more escape proof farming plants should be established for the same periode to support the following evaluation of the zone concept.

As a follow up of the meeting, Lenka established two fast working groups, one expert group which should work out a detailed proposal for zones, and a group which should work out the frames of a research programme.

The expert group proposed 51 zones covering 125 rivers which were considered of high genetic importance.

The sampling of the 125 rivers were done according to the following criteria:

- one should have sample of rivers along all the coastline of Norway, so that conditions following gradients like north-south, inner fiords/ outer coastal areas, temperature and salinity which are believed to be important for the ecological adaption and genetic diversity were included.
- one should include all rivers where the local populations has special features which represent extreme deviation from the "normal",

as regards morphology, behavior, growing speed and ecological adaption.

- one should include rivers with populations with big numbers of individuals, which generally are more resistant against genetic pollution than populations with a fewer individuals.

The detailed designing of the zones followed three main criteria:

- The zones stretches roughly out 20 km from the outlet of the river. Studies indicates that there are a considerable larger procentage of escaped domestic salmons in rivers if salmon farms are located within a range of 20 km from the outlet, than in rivers where farms are located further out. The critera however was to a great part adjusted by topography and local conditions. In fact zones varies from very great ones in the long fjords to rather small ones round the outlet of rivers.
- Between the zone border and the outlet of the river there are other rivers on both sides of the fjord, which in this connection are believed to function as "buffer" rivers. The idea is that escaped domestic salmon in the spawning periode will tend to go up in these rivers before they reach the river one is trying to protect.
- The borders of zones for rivers infected by Gyrodactylus Salaris are drawn roughly where the salinity during the spring flood is 15- 18 pro mille. Experiments show that Gyrodactylus Salaris survives only 15 minutes in waters where the salinity is higher than 15 pro mille. If salmon farms are located in waters with a salinity higher than this, one should be fairly safe that the farms will not turn out to be

breeding places for this particular parasite.

The research group recommended a programme covering the following aspects:

- A monitoring programme covering a sample of rivers where zones are established, compared by rivers with no zones.
- The impact on genetic diversity from escaped domestic salmon.
- The development of genetic dominant markers to be used in pilot experiments to study the genetic effects on populations of wild fish through generations.
- The studies of the behaviour of escaped domestic salmon, particularly on the question of their spawning success.
- The development of escape proof technology in fish farming plants.
- The development of improved technology for disinfection of waste water from production and slaughtering units.
- Veterinary research, with particular emphasis on the pattern of two-way spreading of diseases between fish farming plants and wild populations.

The research activities are recommended to be implemented within an annual financial framework of 5 million N kr, and within a period of 6 years. A follow-up programme were recommended at the end of the 6 years- period, particularly with a view to the genetic consequences.

PUBLIC HEARING OF THE PROPOSAL

The proposals of the expert group were sent on a public hearing by The Ministry of Environment, and The Ministry of the Fisheries, late June. The time schedule is that the final decision on whether to establish protection zones or not will be made by the two ministries in course of 1988.

As for Norway, the concept of protection zones is a new strategy in the field of the protection of marine genetic resources. The protection zones is an effort to protect genetic resources in situ, and is regarded as a supplement to the salmon gene bank project, which has been going on for a few years. The monitoring of the research-programme is carried out by the gene-bank-project.

Whether the zones will prove to be an effective measure against genetic pollution and the spreading of fish diseases remains to be seen. However faced with the challenge of preserving genetic diversity in a time where more and more marine species are being commercially cultivated and farmed and more and more of the coastal zone areas are being occupied for mariculture we think the zone concept is well worth to be tried out and evaluated. The doubts on the real effects of the zones is in our opinion an argument for their establishment on a temporary basis, not against it.

If the zones should turn out to have no significant effects, we will simply terminate the project at the end of the 5 year period. But if they should prove to contribute to the preservation of genetic diversity, it would be a big failure not to establish them now, given the possible speed of the reduction of genetic diversity that I mentioned earlier.

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

ORGANISATION POUR LA CONSERVATION DU SAUMON DE L'ATLANTIQUE NORD



CNL8821

COUNCIL

PAPER CNL(88)21

POTENTIAL IMPACTS OF SALMON FARMING ON WILD STOCKS

R-95

POTENTIAL IMPACTS OF SALMON FARMING ON WILD STOCKS**1. INTRODUCTION**

- 1.1 The Atlantic salmon has colonised roughly its present distribution range since the last glaciation some 10,000 years ago. Representatives of the salmonid group of fish have been found in fossils dating back 5 million years. For the first time in the evolutionary history of the salmon man has made a sudden intervention to artificially propagate domesticated, selectively bred Atlantic salmon on a large and rapidly expanded scale. The advent of this salmon farming industry is an exciting and valuable development. It may even exert some degree of protective influence, at least economically, on the wild stocks. Nevertheless, this new industry could pose new threats to the wild stocks and such concerns have been expressed by a number of national and international organisations.
- 1.2 This paper, which should be read in conjunction with the detailed review attached (Annex 1) is prepared in accordance with the decision of the Council at its Fourth Annual Meeting. It presents a summary of the potential threats, the activities of other organisations and suggests possible action by the Council of NASCO.

2. POSSIBLE INTERACTIONS BETWEEN FARMED AND WILD FISH**Production of farmed fish**

- 2.1 Salmon aquaculture is not new. The first commercial salmon hatchery was established on the Rhine in 1852 and by the turn of the century hatcheries had been established in almost every salmon producing country. The recent large scale expansion of salmon farming is, however, unprecedented. The industry has expanded from a production of 10 tonnes in 1970 to a production by eight countries of over 65,000 tonnes in 1987. There are estimates of a production of between 90,000 and 259,000 tonnes by 1990. This may be seen in relation to a wild salmon catch averaging under 10,000 tonnes over the last twenty years (Fig. 1). The attached review, examines the occurrence and behaviour of farmed fish in the wild (Section 2), the possible genetic interactions (Section 3), diseases and parasites (Section 4), the introduction of non-indigenous salmonids (Section 5), economic interaction (Section 6), and the impact upon the aquatic environment (Section 7).

Occurrence of farmed fish in the wild

- 2.2 Farmed salmon may occur in the wild as a result of accidental release (escape) or deliberate release. There is direct evidence that salmon farm escapees are caught in the Faroese long line fishery. It has been estimated that on average 15% of the fish held in fish farm cages escape accidentally. If this percentage is applied to the 1987 harvested production, up to 10,000 tonnes of farmed fish may have escaped to the wild. Recent reports from Norway suggest that up to 13% of the fish ascending rivers in southern Norway may be of farmed origin. In addition to escapees, unwanted parr may be deliberately released into the wild by salmon farmers or given to fishery managers for stocking.

Genetics

- 2.3 The Atlantic salmon is being domesticated by the salmon farming industry; farmed fish have been selected for traits favourable for rearing in captivity, e.g. tameness, growth rate and late maturity. Hatchery production produces marked reductions in genetic variabilities. On the other hand it has been estimated that 2,000 distinct stocks of wild Atlantic salmon exist in Europe and North America. Clear genetic differences can be demonstrated between European, North American and Baltic salmon and studies within these groups have demonstrated genetic differences between and in some cases within river systems. These studies are supported by strong circumstantial evidence of physiological differences which are heritable. Several studies conclude that Atlantic salmon rivers should all be regarded as having genetically separate populations. The adaptive significance of these genetic differences has been demonstrated. The genetic variability in a wild salmon population enables adaptation to differing environmental conditions and therefore assists its long term survival.
- 2.4 In view of the risk of hybridisation posed by the large number of farmed fish in the wild there have been warnings of the need for the formulation of a strategy on how best to conserve the genetic resources that are still available. There has been one recorded instance of the risks of such introductions. The transfer of 350 million chum salmon eggs (from the Kalininka to the Naiba River in the Soviet Union) took place and twenty years later the run of salmon into the Naiba River was virtually extinct. This is an important example because Atlantic salmon show more genetic variability than Pacific salmon.

Introductions, diseases and parasites

- 2.5 The rapidly expanding aquaculture industry has led to an associated increase in the number and severity of diseases of farmed fish and such disease problems have led to growing concern about the possibility of the introduction and transfer of diseases from farm stocks to wild fish. The possible dangers to wild fish from introduced diseases and parasites have been highlighted by the problem of Gyrodactylus salaris, a monogenean fluke introduced to Norway with imported hatchery stock. The parasite now occurs in more than 28 watercourses and annual losses of salmon are already estimated to be 250-500 tonnes. The ICES ad hoc Study Group on Environmental Impact of Mariculture believed that the importation of exotic species or disease organisms is the greatest environmental risk associated with mariculture because the consequences may be widespread and irreversible. Concern has recently been expressed in the North American Commission of NASCO about the growing interest in the use of rainbow trout in sea-cages along the eastern seaboard of North America. The rainbow trout has the potential to pose a severe ecological threat to Atlantic salmon management.

Environment

- 2.6 The rapid growth of the salmon farming industry has led to an increased awareness that there may be considerable impacts on the aquatic environment, both in freshwater and marine conditions. The most significant characteristics of fish farm wastes as they affect water quality are nitrogen and phosphorous compounds, oxygen consumption, suspended solids and a range of therapeutic and prophylactic chemicals. Although the industry has posed only localised environmental problems to date its continued development, given anticipated growth, is likely to cause greater

problems. Furthermore, there is concern that the behaviour of wild fish may be modified by the presence of cages.

3. ACTIVITIES OF OTHER ORGANISATIONS

- 3.1 The subject of inter-relationships between farmed and wild salmon was considered by the ANACAT Fish Committee at its 1987 meeting. The papers presented dealt mainly with the methods of distinguishing farmed and wild salmon, the occurrence of farmed salmon in the wild and possible impacts. It is intended that this topic could be considered further as part of a mini-symposium on spawning variability in 1989. ICES has established a Working Group on the Environmental Impacts of Mariculture which will meet for the first time in 1988 to consider, among other things criteria for site selection which will minimise the environmental impacts of mariculture.
- 3.2 Several Working Groups concerned with Introductions and Transfers have been established including those of ICES, EIFAC and the North American Commission of NASCO. ICES and EIFAC have prepared Codes of Practice concerning introductions and transfers. Some countries have not endorsed either code of practice while in some other countries the codes are only applied to the import of non-indigenous species. The NAC Working Group has produced a series of recommendations, which apply specifically to salmonids in Canada and the USA and which recognise the potential for adverse genetic effects, in addition to diseases and other ecological interactions, resulting from introductions and transfers. These recommendations included the prohibition of transfers of eastern hemisphere and Icelandic Atlantic salmon, and the use of alternate sources of stocks for both enhancement and aquaculture until appropriate protocols could be developed. Such protocols are now being drawn up by Health and Genetics sub-groups. The NAC group also prepared a computer-based inventory of salmonid introductions and transfers.
- 3.3 The Norwegian authorities have responded to the threats to the genetic resources of their salmon by establishing a sperm bank. Sperm banks have also been established to supply the salmon farming industry with disease free milt and research is currently underway into the feasibility of cryopreserving salmon eggs and embryos.
- 3.4 Commercial trials in the UK of the performance of all female, triploid salmon are now being undertaken. These fish are sterile and therefore avoid the problem to the farmer of maturation in the sea cages. This development, if adopted by the industry, could have favourable implications with regard to possible genetic effects of fish farm escapees. However, further research into the behaviour of these fish in the wild may be required.
- 3.5 In Norway and British Columbia regulations requiring a minimum distance between net-pen facilities and major salmon spawning streams, i.e. aquaculture-free zones, have been introduced.

POSSIBLE ACTION BY THE COUNCIL

- 4.1 NASCO holds the international responsibility for conservation of salmon stocks. There is clearly a need for further research into the effects of the new aquaculture industry on these stocks. Areas of research which have been highlighted include further development of methods of stock identification; assessment of the number of farmed salmon escaping, their migration pattern and whether or not they breed; and the effects of hybridisation between wild and farmed fish if this occurs. The Council might like to consider how such research might be stimulated.
- 4.2 The North American Commission of NASCO established a Bilateral Scientific Working Group in 1986. Their Report has been published separately as Annex 13 to NAC(87)20. It includes recommended actions to be taken to reduce potential risks. The NAC group also developed an inventory of salmonid introductions and transfers. The Council may wish to consider if such actions should be recommended to the North East Atlantic Commission. As with the NAC Group this Commission might well liaise with the ICES Working Group on Introductions and Transfers.
- 4.3 The Council might like to consider whether an internationally agreed Code of Practice to protect wild stocks might be developed. Such a code could consider recommendations on, for example, aquaculture-free zones, the use of local broodstock, the disposal of surplus stock from aquaculture, the possible use of all female triploid stocks etc. A review of the main elements which might form the basis for a code could be carried out by the Council as part of its role in the conservation of salmon stocks under the Convention.
- 4.4 The Council might wish to consider in further detail the mechanics, costs and benefits of establishment of gene banks. In addition to established techniques for cryopreservation of sperm, research is underway in the UK and in other countries on cryopreservation of salmonid ova and embryos. A review of the state of these techniques and other methods of preserving genetic resources could be considered at the Sixth Annual Meeting.
- 4.5 The Council may wish to consider in more detail any evidence on the environmental effects of sea cages on wild stocks and review the evidence for diseases being transmitted from farmed to wild.
- 4.6 The Council may wish to see a review of the legislation relating to the interactions described in this paper as taken from the Laws, Regulations and Programmes Database which now exists.

5. SUMMARY

- 5.1 The attached review requested by the Council examines in some detail the possible interactions between wild and farmed salmon. It concludes that the growth of aquaculture has produced new potential threats to the Atlantic salmon. Some of these are known to be serious but the effects of others are not known. These potential threats include loss of genetic variability, to introduction and transfer of diseases and parasites and changes in the aquatic environment. A number of organisations are studying the evidence for some of these interactions. The Council of NASCO may wish to consider which action it should take. Some options are listed above.

Secretary
Edinburgh
18 May 1988

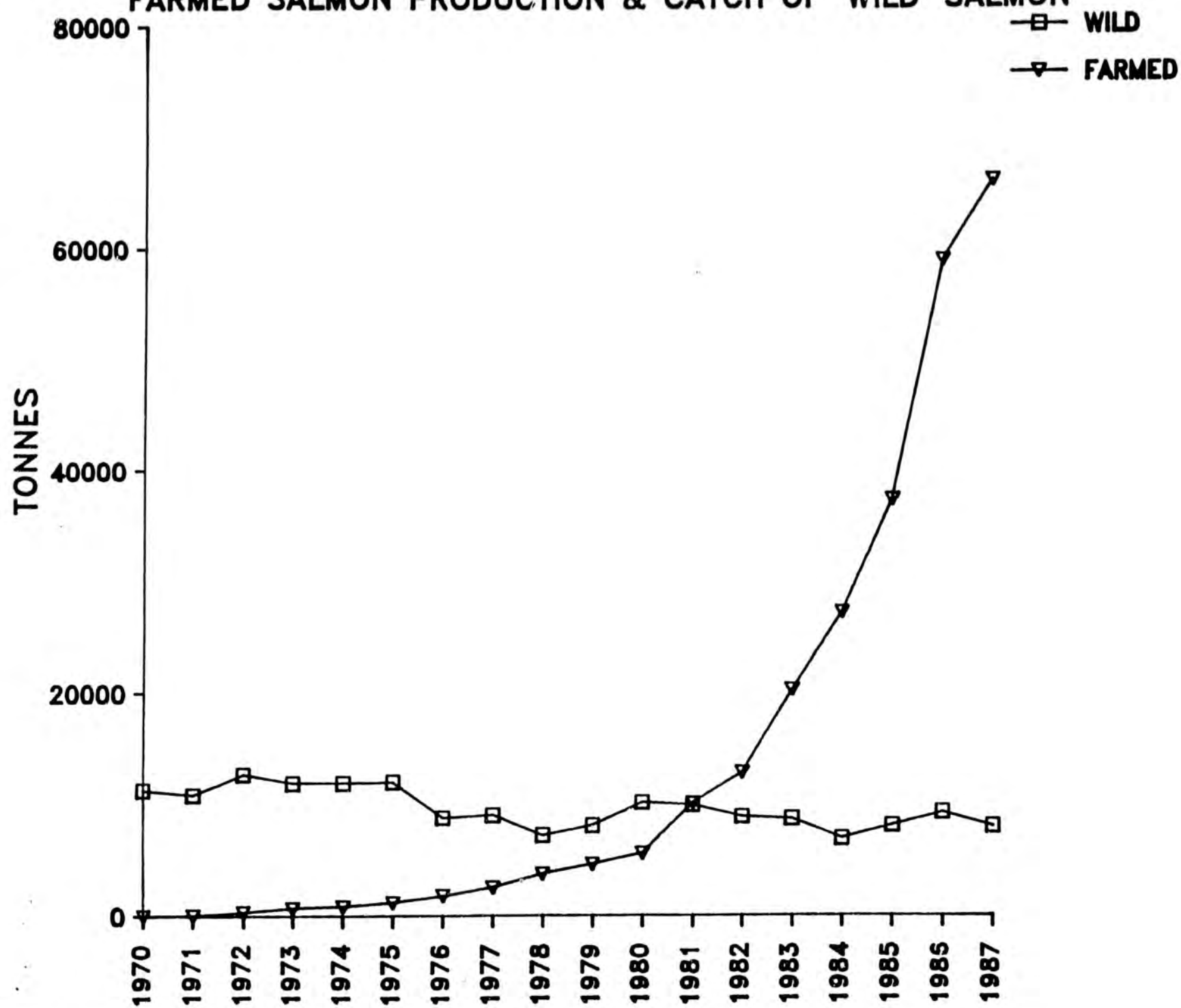
ANNEX 1

1. INTRODUCTION:

- 1.1 At its Fourth Annual Meeting the Council agreed that a brief review of the potential threats from salmon aquaculture on wild stocks be undertaken by the Secretary, including information on the activities of other organisations and the role NASCO may have in this matter. This paper concerns principally the salmon farming industry since this is the most rapidly expanding section of salmon aquaculture. Many of the potential threats also apply to the other sections of salmon aquaculture-enhancement, stocking and ranching.
- 1.2 There has been a recent large scale expansion of salmon aquaculture with the development of salmon farming i.e. rearing salmon in a system of total protection to the time of harvest (see Figure 1). In 1987, the industry produced over 65,000 tonnes of farmed salmon. The majority of this production (90%) was from Norway and Scotland other countries have also developed salmon farming on a significant scale. Recent reports have indicated scope for further large scale increases in production. For example, a recent Norwegian study estimated that a market potential of $120,000 \pm 30,000$ tonnes will exist by 1990. Other estimates suggest a production level in Europe alone of $140,000 - 259,000$ tonnes by 1990 with additional significant production from Chile, Eastern Canada and the United States of America. In the long term the most likely constraints to production within these estimates are economic with market saturation reducing prices, and increased capital costs associated with more difficult sites reducing profitability (Shaw and Muir, 1987). However, over the last ten years there has been continued growth with only short term reductions in the rate of growth reflecting problems associated with smolt supply and disease.
- 1.3 The advent of salmon farming is an exciting and valuable development and there is much to admire in the energy and growth of the new industry. The industry produces a high quality product with all year round availability and has created employment opportunities in remote rural communities. Furthermore, the industry's research and development programmes have provided much scientific information regarding growth patterns, survival and maturity of the Atlantic salmon (Laird and Needham, 1985), although this information has principally been of value to the salmon farmer. However, there is growing concern about possible interactions between farm reared salmon and the wild stocks. Among the organisations that have expressed their concern are the Atlantic Salmon Trust (UK), the Atlantic Salmon Federation (North America), Restoration of Atlantic Salmon in America Inc (USA), the Nature Conservancy Council (UK) and the Directorate for Nature Management (Norway).
- 1.4 This paper is a review of the available literature on the possible interactions. These interactions include genetic interactions such as intraspecific hybridisation, ecological interactions between Atlantic salmon and introduced species, transfer of diseases and parasites from farmed to wild fish, economic interactions and interactions with the environment of wild salmon. We have attempted to bring together information from a variety of sources and in general terms place it in some perspective so assisting the Parties to the NASCO Convention to consider what action might be taken in the light of the Convention which calls for the conservation of salmon stocks.

FIGURE 1

FARMED SALMON PRODUCTION & CATCH OF 'WILD' SALMON



2. THE OCCURRENCE AND BEHAVIOUR OF FARMED FISH IN THE WILD

- 2.1 Clearly, some of the interactions noted above require the occurrence of farmed fish in the spawning and nursery areas of the Atlantic salmon. There is now growing evidence that substantial numbers of farmed Atlantic salmon have gained access to the wild through accidental release (escape) and deliberate release.
- 2.2 Accidental releases of farmed salmon may occur through handling errors, faulty gear, weather damage, predator damage or other forms of damage (e.g. vandalism, collisions etc.). In sheltered sites, simple square or rectangular cage units, capable of containing a stock of about 5 tonnes, are frequently used. The flotation collar of such units is intrinsically weak so the frequency of failure may be relatively high, but individual losses resulting from such failures may be relatively low (Institute of Aquaculture, 1987). As more exposed sites have been developed more sophisticated units capable of containing between 100-150 tonnes have been designed e.g. Bridgestone "High Seas" cage. A single incident involving one of these cages could result in a massive loss of stock to the wild although the frequency of failures may be relatively low (Institute of Aquaculture, 1987).
- 2.3 In 1986 direct evidence that salmon farm escapees were being caught in the Faroese long-line fishery became available. Muscle tissue canthaxanthin analysis revealed that 3% of a sample of 219 fish were of farmed origin having escaped after the smolt stage (Anon, 1987a). Furthermore, single incidences involving the escape of significant quantities of farmed salmon have been reported (e.g. 20-30 tonnes (Hansen et al, 1987); 90,000 salmon (Maitland, 1987); and 30,000 salmon (Mills, 1987)). It has been estimated that on average 15% of the fish held in fish farm cages escape accidentally (RASA, 1987). If this figure is applied to the 1987 production, approximately 2.5 million fish (up to 10,000 tonnes) of farmed fish may have escaped to the wild. Evidence from freshwater rainbow trout cage units has indicated that harvests of between 2.5 - 5% of total cage production may occur in the surrounding water body (Phillips et al, 1985). Recent reports from Norway suggest that up to 13% of the fish ascending rivers in southern Norway may be of farmed origin (see CNL(88)22). Studies in Norway have shown that immature farmed fish released into the wild migrated to North Atlantic feeding areas whereas mature fish entered rivers at random when they were ready to spawn (Hansen et al, 1987).
- 2.4 In addition to accidental release, surplus farm stock may be released or be available for release into the wild. High pre-smolt growth rate produces one year old smolts (S1s) thereby enabling early transfer to marine units and reducing the cost of the expensive freshwater stage (Naevdal, 1981). There may be other advantages in that it has been reported that one year old smolts produce a lower grilting rate than two year old smolts thereby reducing the problems posed by maturation (Ritter and Newbould, 1977; Laird and Needham, 1985). Those parr that do not smoltify after 1 year (the potential S2s) are largely unwanted by the salmon farmers although if parr maturation has no deleterious effect on later age at maturity there may be a role for precociously mature male parr in reducing the generation interval in breeding programmes (Naevdal, 1983). However, in general, unwanted potential S2 smolts are removed during grading and either released into neighbouring rivers, sold to fishery managers or other fish farms, given away or rarely killed (Maitland, 1987; Mills, 1987). In some cases these smolts have been used to stock rivers which have lost their salmon stocks e.g. River Thames, England and River Carron, Scotland. In addition, however, they have been released into rivers already containing salmon populations.

Again the scale of the problem is largely unknown but individual large scale releases are known. For example, Maitland (1987) reports that 60,000 of these fish were released into the river Ness system and 8,000 were released into a small stream flowing into Loch Lomond. With the rapid expansion of the salmon farming industry enormous numbers of smolts are now being produced. For example, Norway now has the capacity to produce 183 million smolts a year, enough to give a grow-out of 130,000 tonnes and it is estimated that in excess of 23 million smolts will be produced in Scotland in 1988.

3. GENETIC INTERACTION:

- 3.1 Salmonid fish exhibit striking ecological and morphological intraspecific differences between and even within various waters. The widespread distribution and well marked homing instinct of the Atlantic salmon are attributes favouring the development of distinct stocks i.e a stock is a population which differs genetically from other populations of the same species (Wilkins, 1985). On the basis of circumstantial evidence the species has often been subdivided into genetically distinct sub-units (Ryman, 1983). For example, Saunders and Bailey (1980) estimated that 2000 stocks of Atlantic salmon exist in Europe and North America.
- 3.2 Recent electrophoretic studies have demonstrated clear genetic differences between European, North American and Baltic salmon. Moller (1970) demonstrated regional differences in North American salmon populations and although Payne (1974) argued that there was a latitudinal cline in North America, an analysis of more extensive data by Verspoor (1986) did not support this argument. Payne et al (1971) also demonstrated regional differences in British and Irish salmon populations but analysis of more extensive data by Cross and Healey (1983) provided unequivocal evidence of stock discreteness (Thorpe and Mitchell, 1981). Similar evidence was presented by Stahl (1983) for Baltic salmon where discreteness within and between river systems was demonstrated. These electrophoretic studies are supported by strong circumstantial evidence in the form of different physiological capacities which have been shown to be heritable and morphological differences between river populations (Thorpe and Mitchell, 1981). Cross and Healey (1983) concluded that the rivers in their study and possibly all Atlantic salmon rivers should be regarded as genetically separate populations.
- 3.3 Several studies have demonstrated the adaptive significance of genetic differences in salmonid populations. Riddell et al (1981) compared juvenile salmon from two tributaries of the Miramichi River and demonstrated that the juveniles from the river characterised by higher flows had more fusiform bodies and longer fins than fish from the slower flowing river. By rearing the progeny of salmon from the two tributaries under identical conditions they demonstrated that this interpopulation variation in body morphology had a genetic basis. Winter et al (1980) demonstrated that transferrin genotypes exhibit differential resistance to infections such as BKD and Kanis et al (1976) showed that mortality in salmon, particularly for the egg and alevin stages, was heritable. There is also evidence that the homing ability of salmon may be under genetic control. For example, Bams (1976) showed that while imprinting alone brought back some of an introduced donor stock of pink salmon, addition of the locally adapted paternal genes improved the returns. Browne (1986) considered that the differences in the relative performance of hatchery and wild smolts were mainly associated with accuracy of homing and overall survival. Ferguson (1986) concluded that

genetic variability is a key factor in a populations capacity to produce new adaptations in response to environmental change and therefore to its long term survival.

- 3.4 During the selection of stock for the developing salmon farming industry, the genetic diversity present in wild stocks enabled the farmers to select for rapidly growing, late maturing fish which were suitable for improvement of productive capacity e.g. Norwegian river Alta stock (Naevdal, 1981). Selective breeding has subsequently resulted in significant genetic gain in growth rate, reduced frequency of early sexual maturation and tameness of the fish (Gjedrum, 1985). The Atlantic salmon is being domesticated, a process including selection for calmness, little fear of handling and tolerance to noise and the presence of people (Gjedrum, 1979). In contrast to the genetic diversity demonstrated in wild salmon, hatchery production results in significant reductions in genetic variation compared to the wild fish from which they were derived (Ryman and Stahl, 1980; Cross and King, 1983). This loss of genetic variation has been attributed to the use of small numbers of parents and the effects of genetic drift (Allendorf and Phelps, 1980; Cross and King, (1983), Johansson (1981) and Cross and King (1983) believed that hatchery procedures select for salmon well adapted to rearing conditions but less well adapted to survival in the wild. The salmon farming industry has also resulted in international transfers of stock. For example, Norwegian stock have been imported into Scottish fish farms and vice-versa and Finnish and Scottish stock have been imported to aquaculture facilities in Maine. In addition techniques such as gene implantation and induced ploidy may be used by the salmon farming industry (NAC, 1987).
- 3.5 In view of the genetic differences between hatchery and wild stocks, Stahl (1983) warned that there is a strong need "for the formulation of a strategy of how to best conserve the genetic resources that are still available". There are very few examples in the scientific literature of studies that have monitored the genetic effects of hatchery stocks on the recipient wild stock's performance. Reisenbichler and McIntyre (1977) compared the survival of offspring from matings of hatchery x hatchery, hatchery x wild and wild x wild, summer steelhead, *Salmo gairdneri*. They demonstrated that in the study streams wild fish had the highest survival rates and they concluded that if the hatchery fish interbred with wild fish there may be a reduction in smolt output. Such introgression was demonstrated by Taggart and Ferguson (1986) as a result of a 15 year stocking programme in the Erne-Macnean system. The potential dangers of introgression have been described by Altukhov (1981). Between 1964-1971 350 million fertilised chum salmon (*Oncorhynchus keta*) eggs were transferred from the Kalininka river to the Naiba river on Sakhalin Island. By 1969-1970 there had been a genetic shift in the later running Naiba stock and by 1985 the population, which previously supported a run of about 650,000 chum salmon, was virtually extinct. Thorpe (1987) stressed the importance of this example for managers of Atlantic salmon stocks which are known to exhibit more genetic variability than Pacific salmon stocks.
- 3.6 Saunders and Schom (1985) believed that the effective spawning population of wild salmon populations, which may comprise sexually mature parr and anadromous adults of various ages, even in small populations may be quite large thereby leading to low levels of inbreeding. Maitland (1987) considered that the genetic problem associated with farmed salmon stems from the fact that farmed salmon became more genetically distinct from wild stocks with each generation in captivity and that large numbers of these domesticated fish are now being released into river systems. In the past, relatively small numbers of fish have been moved or have strayed from one system to

another and these incomers are less likely to be successful and so have little genetic impact when present in small numbers (Maitland, 1987). Similarly, Isaksson (1985) considered that large scale releases of ranched salmon, which are genetically distinct from neighbouring wild stocks, could have an effect on the wild stock if straying occurred, whereas moderate releases would have minimal effects.

4. DISEASES AND PARASITES:

4.1 The rapidly expanding aquaculture industry has led to an associated increase in the number and severity of diseases of farmed fish (Smith, 1985). For example, Hitra disease, which was first identified in 1979, has recently caused severe losses in Norway (Anon, 1987b). Such disease problems on salmon farms have led to growing concern about the possibility of transfer of diseases and parasites from fish farms to wild stocks. The potential negative interactions are not one sided, with both farmed and wild stocks potentially at risk (Anderson, 1987). In the case of diseases introduced to the wild, however, treatment is not usually possible while, in contrast, the farming industry has responded rapidly to disease problems e.g. a vaccine against Hitra disease has already been developed (Anon, 1987b). In addition, there have been considerable trans-Atlantic and other international movements of salmonid stocks associated with the aquaculture industry. Mills (1987) considered that although considerable concern has been expressed regarding the introduction and transfer of disease with stock there is little record of wild fish being affected by farm stock. Similarly, Cobham Pesource Consultants (1987) considered that the available data provide no conclusive evidence of significant adverse effects. However, as Anderson (1987) points out, transmission of disease from farmed to wild stock is hard to establish.

4.2 Egidius (1987) describes the import of furunculosis, Aeromonas salmonicida, to Norway with Scottish salmon smolts. The disease has subsequently been reported from a free living salmon. Similarly, although Munro et al (1976) reported the spread of Infectious Pancreatic Necrosis from farmed stock to wild fish they demonstrated a low prevalence and limited distribution of the virus in wild fish and the infection appeared to be "inactivated" within a short distance of the farm. Concern has recently been expressed about the possible import of Infectious Hematopoietic Necrosis (IHN) with stock movements from the west to east coasts of North America (NAC, 1987). IHN was, isolated from two rainbow trout farms in France during 1987. Prior to this the virus had not been isolated from Europe (ICES, 1987). The most severe documented damage to wild salmon stocks which appears to have resulted from international stock movements has been caused by the monogenean fluke Gyrodactylus salaris and highlights the dangers of introducing exotic diseases or strains of diseases and parasites with international stock movements. The most likely hypothesis is that this parasite was introduced to Norway and subsequently dispersed by fish stocking from infected hatcheries (Dolmer, 1987). The parasite now occurs in more than 28 Norwegian salmon rivers and appears to pose one of the most serious threats to salmon in Norway. It has been estimated that annual losses of 250-500 tonnes of salmon have occurred (Johnson and Jensen, 1986) and the Norwegian authorities are now treating entire river systems with rotenone in order to try to eliminate the parasite. Gyrodactylus has recently been added to the list of notifiable diseases by the Ministry of Agriculture, Fisheries and Food in the United Kingdom as a precautionary measure.

- 4.3 Cage rearing can cause eutrophication and this has been linked to increased parasite loads in some fish populations and pathogenic fungal infections are more common in eutrophic waters. Bacterial numbers are also related to trophic status (Philips et al, 1985).

5. INTRODUCTION OF NON-INDIGENOUS SALMONIDS:

- 5.1 Non-indigenous species, with attributes favourable to the fish farmer or salmon rancher, have been introduced into the North Atlantic, often accompanied by accidental introductions of disease organisms (Institute of Aquaculture, 1987). The ICES ad hoc Study Group on Environmental Impact of Mariculture believe that the importation of exotic species or disease organisms poses the greatest environmental risk of mariculture since the consequences may be widespread and irreversible.
- 5.2 In eastern North America, coho salmon (Oncorhynchus kisutch), which were introduced in order to develop an aquaculture industry based on sea-ranching, have spawned regularly in the Cornwallis river, Nova Scotia. It is thought that there would be little interaction between juvenile coho and Atlantic salmon because of habitat segregation. However, superimposition of redds could occur in rivers where spawning substrate is limited and juvenile interactions could occur in rivers where Atlantic salmon occur in pools e.g. Newfoundland (NAC, 1987). Concern has recently been expressed about the growing interest in the use of rainbow trout (Salmo gairdneri) in sea-cages along the eastern seaboard of North America. This species has the potential to pose a very severe ecological threat to Atlantic salmon management (NAC, 1987).
- 5.3 In Europe, coho salmon eggs have been imported to France since 1971 as part of a cage rearing project in Brittany and Normandy. Considerable escapes and intentional releases have occurred but as with many other introduced populations of Pacific salmon the coho appear to have died out after initial spawning success (Euzenat and Fournel, 1981). Pink salmon, Oncorhynchus gorbuscha, introduced to the Kola peninsula have aggregated in Norwegian rivers since 1960 and successful spawning has occurred (Bjerknes and Vaag, 1980). However, Solomon (1979) considered that since this species migrates to sea as fry before commencing feeding the possible adverse interaction with native salmonids is much reduced.
- 5.4 Solomon (1979) concluded that, before any introduction is undertaken, it is desirable to investigate any possible risks including adverse competitive interactions and introduction of new disease organisms or strains of disease organisms. Protocols regarding introductions and transfers are presently being prepared by the Bilateral Scientific Working Group on Introductions and Transfers of the North American Commission of NASCO through health and genetic sub-groups.

6. ECONOMIC INTERACTIONS:

- 6.1 Prior to the advent of salmon farming, trading in Atlantic salmon was very much a seller's market (Stansfeld, 1985) with availability of the wild stocks and regulations governing the harvest, rather than the demand, determining the supply from the fisheries (Anderson, 1987). The advent of a large supply of high quality, fresh farmed salmon with all year round availability has had a marked effect on the traditional wild salmon market with consequences for commercial netmen.

- 6.2 In Scotland the effect of the influx of farmed salmon was to reduce and stabilise salmon prices. At the same time the premium price enjoyed by wild salmon over farmed salmon has been generally reduced in Scotland and Norway. In Canada, farmed salmon attain a premium price (Anderson, 1987). Tuomi (1987) believed that the development of the salmon farming industry would end the traditional commercial fishery for salmon in Canada. In Scotland, price reductions have resulted in many marginal stations closing and other stations working shorter seasons. These changes are likely to result in a change in the pattern of exploitation of salmon and may favour the development of salmon ranching (Stansfeld, 1985).
- 6.3 Another effect of the all year round availability of fresh salmon has been a reduction in the market for frozen salmon in Scotland. It is possible that this market will be particularly hard hit by the salmon farming industry. The small market that still exists for frozen salmon in Scotland is now largely supplied by the Greenland and Faroese fisheries (Stansfeld, 1985).
- 6.4 Hansen et al (1987) reported that reared fish augment the commercial catches of wild salmon in Norway but warned that if an increased output of reared fish lead to higher fishing effort in mixed stock fisheries natural salmon stocks may be over-exploited.

7. IMPACT ON THE AQUATIC ENVIRONMENT:

- 7.1 The rapid growth of the salmon farming industry has led to an increased awareness that there may be considerable impacts on the aquatic environment, both in freshwater and marine conditions. This concern is shared by conservationists and the fish farmers who fear that the harmful feedback could affect the economic viability of the farm (Gowen and Bradbury, 1987).
- 7.2 The most significant characteristics of fish farm wastes as they affect water quality are nitrogen and phosphorous compounds, oxygen consumption and suspended solids. The impact of these wastes is influenced by the nature and amount of waste produced and the characteristics of the recipient environment (Institute of Aquaculture, 1988). In addition a wide variety of chemicals including pharmaceuticals and other chemicals used in disease treatment, materials incorporated in feeds and treatments applied to equipment may enter the recipient water.
- 7.3 Salmon cage culture understandably requires the maintenance of an environment suitable for salmon and studies on the impact of cage culture of rainbow trout have been unable to demonstrate any adverse impact of eutrophication (Phillips et al 1985). However, vitamin and trace materials may have subtle effects and there is evidence that the toxicity of Gyrodinium aureolum is enhanced by biotin, a constituent of fish farm wastes. There are also examples of localised phytoplankton blooms occurring in enclosed sea lochs causing mortality of farmed stock. Problems associated with sedimentation and reduced dissolved oxygen concentrations are likely to be localised in nature. These problems are likely to be more severe on farms using fresh fish or moist pelleted feeds.
- 7.4 Solbe (1982) carried out a questionnaire survey of fish farms in the United Kingdom and concluded that there was little deterioration in either biotic indices or fishery status as a result of fish farm effluent. Where fishery status had declined intensive use of water was a common feature. Similarly, Alabaster (1982) showed that downstream fisheries were generally not adversely affected unless the total flow of recipient water was less than

5 litre/sec/tonne of annual production. Maitland (1985) considered that more information was needed on the effect after discharge of therapeutic and prophylactic chemicals.

- 7.5 There is increasing evidence that the behaviour of wild fish may be modified by the presence of cages. Clearly it is important to ascertain whether the migratory behaviour of salmon is adversely affected by farming in and around rivers supporting wild populations of salmon (Phillips et al, 1985).

8. ACTIVITIES OF OTHER ORGANISATIONS:

- 8.1 At its 1987 meeting the ANACAT Fish Committee of ICES held a special topic session on the "Inter-relationships between wild and farmed salmon and wild and farmed eels". Nine papers were presented on the inter-relationships between farmed and wild salmon. These papers covered methods of distinguishing reared and wild salmon, the occurrence of farmed salmon in the Faroese fishery and the possible impact of farmed fish on the wild stocks. The Committee endorsed a proposal for a mini-symposium at the 1989 Statutory Meeting to discuss "Spawning Variability and the Implications for the Dynamics and well being of Stocks". The Committee considered that contributions to this symposium could include comparative studies of wild and cultured anadromous fishes as relative contributors to the reproductive potential of the stocks.
- 8.2 Both ICES and EIFAC have established Working Groups to consider the possible adverse effects of introductions/transfers of aquatic organisms. The ICES Working Group on Introductions and Transfers of Marine Organisms prepared a Code of Practice to Reduce the Risks of Adverse Effects arising from Introductions of Non-Indigenous Marine Species which was adopted by ICES in 1973. A similar code of practice was prepared for inland aquatic organisms by the EIFAC Working Party on Introductions. These Codes of Practice recommend careful assessment of the effects of an introduced species and lay down guidelines to minimise the risk of introducing disease agents with the introduced organism. However, some countries have not endorsed either Code of Practice (NAC, 1987) while in some other countries the code is only applied to the import of non-indigenous species (ICES, 1987). Concern about the trans-Atlantic and other transfers of Atlantic salmon relative to the genetic and ecological implications of stock mixing has recently been expressed by the ICES Working Group on Introductions and Transfers of marine organisms. This Group recommended that studies on stock identification and the effects of stock movements be encouraged. The Group is also establishing a computerised inventory and bibliography of Introductions and Transfers of marine organisms.
- 8.3 In 1987, the Bilateral Scientific Working Group of the North American Commission on Salmonid Introductions and Transfers made a series of recommendations to the North American Commission of NASCO regarding both introduction and transfer of salmonids to the eastern sea-board of North America. These recommendations recognised the potential for adverse genetic effects, in addition to disease and other ecological interactions, resulting from introductions and transfers. These recommendations included the prohibition of transfers of eastern hemisphere and Icelandic Atlantic salmon and the use of alternate sources of stocks for both enhancement and aquaculture efforts from within the local area until appropriate protocols can be developed. The Group also established a computerised database on

salmonid introduction transfers. Since their report was published the Group has established Health and Genetics sub-groups whose primary tasks are to develop protocols and/or model fish health and genetics programmes for the protection of wild stocks in the NAC area.

- 8.4 In response to a recommendation from an ad hoc Study Group ICES has established a Working Group on the Environmental Impacts of Mariculture which will meet for the first time in 1988. The Working Group will review ongoing research projects on environmental issues related to mariculture; evaluate techniques and monitoring strategies; determine criteria for site selection which will minimise environmental impacts and compile a directory of chemicals and their properties currently used in mariculture.
- 8.5 The Norwegian authorities consider that salmon farm escapees represent a potentially greater threat to natural genetic resources than either surface water acidification or *Gyrodactylus*. The proportion of farmed fish occurring in some Norwegian rivers is expected to increase above the present level of 13% as the industry continues to expand. With this problem, together with surface water acidification and *Gyrodactylus* in mind, the Directorate for Nature Management has established a national gene (sperm) bank for wild salmon (see paper CNL(87)47 for details). In the first year of a 10 year programme, field techniques were developed and samples were collected from 47 different stocks. A gene (sperm) bank designed to provide the Scottish salmon farming industry with large volumes of disease free milt has been established at Stirling University's Institute of Aquaculture (Rana, 1988).
- 8.6 Cornerstones of the successful marketing of farmed salmon by Organisations such as the Norwegian Fish Farmers Sales Organisation and the Scottish Salmon Growers Association have been the health value of salmon in the diet and the image of the wild fish occurring in unpolluted waters. The industry has tended to respond rapidly to environmental issues which could adversely affect the marketability of their product, e.g. the use of the antifoulant tributyl-tin. Concern in the industry about the possible degradation of the aquatic environment, particularly in the vicinity of the salmon farm, has led to a growing interest in the production of high digestibility, low pollution feeds. The marketability of these feeds will, however, depend on their expense (Institute of Aquaculture, 1987).
- 8.7 Problems of maturation in rainbow trout farming have led to the development of all female, triploid stocks which are sterile. These fish are now widely used by the trout farming industry in the UK and the techniques are now being tested with Atlantic salmon. Experimental trials have indicated that triploid fish grow slightly less well than diploid fish to the grilse stage but their growth is more predictable and there is no problem of maturation thereby avoiding the labour intensive grading of grilse. Full scale commercial testing of triploid smolts is now being undertaken (Anon, 1986). It remains to be seen if the industry will adopt this technology since the use of hormones, albeit one generation away from harvested fish, may be perceived as a threat to the marketability of the product. The adoption of this technology by the industry would have implications in the consideration of the possible genetic interactions of farmed and wild stocks. Sterile fish farm escapees clearly cannot interbreed with wild fish and in the absence of maturation it is possible that these fish might not even enter freshwater. However, if they did ascend into freshwater in large numbers there may still be the possibility of adverse interactions with wild stocks. Maitland (1987) describes several examples of biological control where mass release of sterile males has been used in order to control unwanted populations e.g. the sea lamprey *Petromyzon marinus* in the Great Lakes. The release of sterile

females might be expected to have less of an effect than release of sterile males although the behaviour of these fish has not yet been studied in the wild.

- 8.8 In Norway and British Columbia regulations laying down required separation distances between cage units have been introduced. In addition, regulations requiring a minimum distance between net-pen facilities and major salmon spawning streams (3km) have been introduced. In the Maritime Provinces of Canada the density of salmon cage culture is restricted to not more than 24 cages and a maximum of 2 hectares per lease. Recent Norwegian legislation has placed a complete embargo on the movement of any salmonid fish from one river system to another and on the large scale release of smolts (Maitland, 1987). In Sweden, a recent statute has enabled salmon rivers to be classified on being of national interest on the basis of its genetic characteristics.
- 8.9 In the United Kingdom, the Nature Conservancy Council (NCC) has recently commissioned two reports (Maitland, 1987; Institute of Aquaculture, 1988) on the environmental impacts of salmon farming. Maitland's report concerns the genetic impact of farmed Atlantic salmon on wild populations and he concludes:

"The threats to wild stocks from salmon farming are potentially serious and must be taken account of in the development of the industry. The current practice in Scotland of the release of large numbers of parr and smolts from fish farms into lochs and rivers may result in the deterioration of wild salmon stocks. This practice should be stopped and suitable research into the various potential problems posed by salmon farming initiated. The development of codes of practice is an important step in solving the problem....."

The NCC plans to promote the development of nature conservation guidelines for the marine environment using the Institute of Aquaculture report and other commissioned work (Cobham Resource Consultants, 1987). Guidelines on nature conservation and freshwater fish farming have already been developed.

- 8.10 A further report entitled "An Environmental Assessment of Fish Farming" (Cobham Resource Consultants, 197) has recently been prepared for the Countryside Commission for Scotland, the Crown Estate Commissioners, the Highlands and Islands Development Board and the Scottish Salmon Grower's Association. The report concludes that, to date, the industry has posed only limited environmental problems, but that the continued development, given anticipated growth, is likely to pose greater problems. Recommendations as to good practice in fish farm siting, design and management were made although nature conservation was outwith the remit of the report.

9. POSSIBLE ROLES FOR NASCO

- 9.1 This paper has attempted to bring together information from a variety of sources and to place it in some perspective thereby assisting the Parties to the NASCO Convention to consider what action might be taken in the light of the Convention which calls for the conservation of salmon stocks.

- 9.2 The salmon farming industry has developed extremely rapidly and there is clearly a need for further research into the possible effects of the industry on wild stocks. Hansen et al (1987) considered that there is an urgent need to estimate the number of fish escaping from farms; to study their migration pattern, and to investigate their possible effects on wild stocks. The ICES Working Group on Introductions and Transfer of Marine Organisms recommended that studies be encouraged by member countries to determine means of stock identification and to examine the effects of trans-Atlantic and other transfers of Atlantic salmon and the NAC Bilateral Scientific Working Group on Introductions and Transfers considered that there was an urgent need to develop new techniques to study the effects of intra-specific hybridisation. The Council might like to consider if NASCO has a role to play in stimulating this research.
- 9.3 The North American Commission of NASCO established a Bilateral Scientific Working Group in 1986. This group reported back to the Commission at its Fourth Annual Meeting and their report has been published separately as Annex 13 to NAC(87)20. The Report included recommended actions to be taken to reduce the potential risks to eastern seaboard salmon stocks until appropriate protocols can be developed. These protocols will include model programs for the protection of fish health, genetic integrity and productivity of salmonid stocks. The NAC Working Group also developed an inventory of computer-based salmonid introductions and transfers. Council may like to consider if such actions should be considered for the entire Convention area.
- 9.4 The Council might like to consider the production of a Code of Practice to minimise the adverse effects of aquaculture on wild stocks. Such a Code of Practice could consider recommendations such as "aquaculture free zones"; the use of all female triploid stock; the use of local broodstock; disposal of surplus stock etc. A review could be prepared for consideration by the Council at its Sixth Annual Meeting.
- 9.5 Atlantic salmon gene (sperm) banks have been established in Norway in response to concern about loss of genetic resources in the wild stocks and in Scotland in order to supply the industry with disease-free milt. Research is presently being undertaken by Cell Systems, a Cambridge (England) based biotechnology company, into cryopreservation of salmonid ova and embryos. The development of cryopreservation and the establishment of gene banks and other methods of maintaining genetic resources such as "pristine preserves" could be reviewed for consideration by the Council at its Sixth Annual Meeting.
- 9.6 The Council may wish to see a review of the legislation relating to the interactions described in this paper as taken from the Laws, Regulations and Programmes Database which now exists.

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MUTUAL IMPACT OF WILD AND CULTURED ATLANTIC SALMON IN NORWAY

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ABSTRACT

The development and current status of the fish farming industry, enhancement and sea ranching of salmon in Norway are briefly described, and an account is given of the natural salmon river populations in different parts of the country.

Record of cultured salmon in the open sea, coastal waters and rivers are briefly reviewed, and so are also migration studies on liberated farmed salmon. Diseases common to wild and cultured populations are described and discussed in relation to mutual impact.

The current situation is discussed in relation to actual and potential effects on natural gene pools and spreading of disease agents. Initiatives to protect natural gene pools are discussed, and experiments to gain additional knowledge of the genetic resources are outlined.

INTRODUCTION

Farming of Atlantic salmon in Norway commenced around 1970, and since then the production has increased steadily. In 1987 the annual production amounted to 47.417 metric tons, and the predictions for 1988 are around 75.000 tons. The production takes place along larger parts of the coast, but is low in southeastern parts and in the northernmost county Finnmark.

Wild Atlantic salmon is found in rivers all along Norway, and despite damage of stocks in southern Norway due to acid precipitation and in mid- and northern Norway due to the parasitic monogenean fluke Gyrodactylus salaris, the total reported catch of salmon has varied between 1050 and 2147 metric tons over the last 27 years. The annual variation in the production of the different rivers is considerable. All rivers seem to have their own stock with specific life histories and productive traits. Investigations of the population structure of Norwegian salmon using gene markers have been conducted by Ståhl and Hindar (1987).

Atlantic salmon has been released in Norwegian rivers for many years to enhance local stocks. They have mostly been released as unfed fry (10-15 millions a year), but also as underyearlings or smolt. Smolts (4-500 000 a year) are released primarily to compensate for damages to recruitment caused by river regulations (Hansen *et al.* 1987). Most fish released are from local stocks (Ståhl & Hindar 1988). Ocean ranching has so far been carried out on an experimental basis only, although the results have been most encouraging (Hansen and Jonsson 1988).

It is a reasonable assumption that the fish farming industry in Norway will continue to increase, and we therefore need to take good care of our several hundred local populations of wild salmon. Moreover the possibilities to augment the stock enhancement work and to develop ocean ranching of salmon should be assessed.

Many questions have been raised about the impact of the growing fish farming industry on the natural salmon populations. This concern has mainly been focused on two aspects; the transfer of disease from farmed to wild fish and the danger of eradicating salmon gene pools by

breaking down isolation mechanisms between stocks, and decreased fitness of the wild salmon due to introduction of nonindigenous gene or gene combinations. Transfer of diseases from wild to farmed fish is also a matter of concern, and for the fish farming industry strong and healthy wild populations with a high degree of genetic variation is a good insurance if the cultured populations should be subject to massive disease infections or unexpected genetic alterations.

The aim of the present case study is to give an overview of the relationship between wild and cultured salmon in Norway, including initiatives to protect the natural gene pools. The greater part of the study is based on published papers and reports, and in addition some discussion on validity of concern is included.

DESCRIPTION OF THE SITUATION

Recent development in farming and ocean ranching of Atlantic salmon has led to an increased proportion of reared fish in nature. Based on fin morphology and scale analysis the proportion of reared fish (ranching and farm escapees) has increased from about 10% in 1986 to about 20% in 1988 in commercial fisheries in Norwegian home waters (Hansen *et al.* 1987a, Lund and Hansen 1988, Lund *et al.* in prep.). If not caught in the fisheries, the adult salmon enter rivers to spawn (Hansen *et al.* 1987b). Using direct observations of body morphology, brood stock surveys in rivers in southern Norway in 1987 revealed that 23 (43%) out of 54 rivers examined contained reared salmon (Gausen 1988). In total of 615 salmon examined 83 (13%) were determined to be of reared origin.

These escaped fish spawn in the streams. For instance, in the small river Imsa there is an annual run of between 100 and 200 mature rainbow trout which have escaped from fish farms. They spawn and they leave the river system as kelts (Jonsson and Hansen, in prep.). The number of viable offspring is extremely low. Because Atlantic salmon is a species native to Norway it is likely that reared salmon can yield viable offspring in nature. However, the reproduction success of reared salmon in nature is still unknown (Ståhl and Hindar 1988).

Experimental releases of farmed Atlantic salmon show that there is a

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seasonal variation in survival. Survival of escaped salmon during their first sea year is much higher for those escaping in spring than for those escaping during the rest of the year (Hansen & Jonsson 1986, 1989). Adults escaping during summer seem to enter rivers at random and behave like homeless fish (Hansen et al. 1987b). When escaping from sea cages at the smolt stage the fish return to the same area from which they escaped and enter rivers in this area to spawn (Hansen et al. 1989).

Reared salmon might affect natural populations in several ways. For example the fluke Gyrodactylus salaris is at present spread to 32 rivers by stocking fish from infected hatcheries. This parasite attacks salmon parr and causes heavy mortality. In 1984 the estimated loss of salmon to Norway was around 250-500 tonnes (Johansen & Jensen 1986), and now the damage is still higher as the fish in more rivers have been infested by the fluke. Salmon smolts are still imported to Norwegian fish farms from other countries, which imposes a continuous risk of importing disease and parasites to which Norwegian salmon stocks are not adapted.

Extinction of local, indigenous fish stocks and erosion of genetic resources are subjects of growing concern to salmon management in Norway. The primary causes of excess salmon mortality in the present century are acid precipitation (Hesthagen & Mejdell-Larsen 1987), and the parasite Gyrodactylus salaris (Johnson & Jensen 1986, 1988). Effects of escapees from salmon farms on natural stocks also is a matter of concern among biologists. For these reasons the Directorate of Nature Management has established a gene bank for salmon based on deep frozen sperm. In 1986 and 1987 sperm collected from a number of salmon rivers throughout the whole country were stored (Gausen 1986 and pers comm.). In total sperm from 69 stocks are by now stored in the sperm bank.

DISEASES

Of the interaction problems between wild and farmed salmonids, diseases is possibly the largest and most serious one. Disease in fresh water farmed fish has been known for considerable time. Sea water farming started more recently, and it was believed that

conditions in seawater would be much better, with cleaner water and less disease problems.

Very little was known about diseases and parasites in free-living marine fishes when the fish farming industry started, and still there are immense gaps of knowledge. It has also appeared that diseases expected to occur only in fresh water, thrive very well in seawater.

The case of the salmon lice, Lepeophtheirus salmonis, is maybe the one giving the best illustration of an interaction between wild and farmed fish. This parasite was well known, it was described by Krøyer as early as in 1838. It is a copepod with a life cycle of 10 stages, 3 pelagic stages and 7 attached to or living on the host. It is found circumpolarly in the northern hemisphere and is host specific for salmonids; the lice disappears from the fish in fresh water within a short time. When and where the free-living fish is infected is not known. The chance for a pelagic-living larvae to encounter its specific host in the open sea, does not seem very large. When wild salmon still were abundant in the rivers, the saying of experienced fishermen was that a high density of lice on the upward migrating fish, was indicative of a good salmon run. Only once, in Canada in 1940, lessions and death probably due to salmon lice were reported (White 1940). Actually, it should have been foreseen that salmon lice could become a potential problem in salmon farming. Under the intensive conditions found in farms, it is no longer a problem for the pelagic larvae to find their spesific host and complete their life cycle producing new larvae easily finding new hosts and so on. It soon became evident that the lice, if present in large numbers, were harmful to salmon. They live on mucus, skin and blood and in the most advanced cases fish are seen with large open lessions especially in the head region. Even if wild-living salmonids arround fish farms have been observed carrying large numbers of lice (Djupvik, pers. com.) lessions or mortality in such fish are not reported.

We still know little about diseases in free-living marine fish, clearly it is among the farmed fish we really encounter the problems. The largest problems are seen in connection with bacterial infections. Vibriosis due to the bacterium Vibrio anguillarum is probably the most well known of such diseases. Vibriosis was one of the economically

most important diseases in marine fish farming, but can now be controlled efficiently through vaccination. Vibriosis is known from a large amount of freeliving marine fish, but epidemics are rarely seen. Along the Norwegian west coast local outbreaks of vibriosis in young saithe are found annually, reaching epidemics proportions in certain years (Egidius et al. 1983). Experiments have shown (Egidius and Andersen 1978) that there is some host specificity amongst V. anguillarum strains isolated from for example rainbow trout and saithe, and more recent investigations have shown that there at least at the DNA level is a slight difference between strains from different hosts (Wiik et al., in press). Mass mortality due to vibriosis is reported in homeward migrating salmonids when entering the rivers, but it does not seem to occur very frequently. Coldwater vibriosis due to V. salmonicida has not yet been reported in wild salmon.

Furunculosis due to the bacterium Aeromonas salmonicida var. salmonicida is another of the important bacterial diseases that must be considered. Furunculosis is endemic in the wild salmonid populations in Scotland, Ireland and Canada, but free-living affected fish are not frequently seen. In fish farms on the other hand the disease can be disastrous and in general of great economic importance. With furunculosis it seems clear that the free-living fish is the reservoir for the disease in farmed fish. In farmed fish the disease outbreaks seem linked with fish density in tanks and cages and other stress inducing factors.

The bacterium Yersinia ruckeri is a newcomer in European fish farms. Even if the disease was believed to be a fresh water one, it has spread to salmon farms all along the Norwegian coast. Possible effects on free-living salmonids are not known. Although the bacterium has been isolated from marine scavenger fish like saithe around affected sea cages, it is not known if the saithe just harbours the bacterium for a short time or if it can be pathogenic also for this and other marine species.

Bacterial kidney disease (BKD) due to Renibacterium salmoninarum is probably the most dreaded of the salmonid diseases mainly because its development is slow and because the diagnostics is difficult and time consuming. BKD was first thought to be purely a disease of farmed

fish, but with improved diagnostic methods the bacterium was also found in wild stocks though its impact there is unknown. We most probably have the same situation as with furunculosis: that the infection reservoir is in the wild stocks, but the disease problems break out under farming conditions. The disease in farms can lead to higher infection rates of wild stocks in the vicinity.

Of fungal disease agents Ichtyophonus hoferi is common and often harmful in several species of marine fish. It has been found in farmed salmon, but until now without showing much effect.

Of parasites the monogenean fluke Gyrodactylus salaris has done great harm in Norwegian salmonid rivers. The fluke is believed to have been imported with smolts for farming from Sweden to Norway in the early seventies. This fluke is now spread to about 30 salmon rivers, many of which are nearly emptied of Atlantic salmon. In the fish farming industry Gyrodactylus is no problem. Infected fish are easily treated and the parasite disappears when the smolts are put into sea water. This is the only disease mentioned here where apparently wild stocks are the losers.

Examples have been given of disease interactions between free living and farmed salmonids, mostly to our knowledge in the disfavour of the farmed fish. Our general knowledge on disease in free living marine populations including salmonids, is still far too restricted, but there clearly is reason for great consideration and carefullness in movements of fish from different regions.

GENETIC VARIATION AND GENETIC STRUCTURE OF SALMON IN NORWAY

Population structure of salmon in Norway

Ståhl and Hindar (1988) have made a comprehensive monograph of the Norwegian salmon stocks with reference to the population structure, number of spawners (population size) and differences within and between wild and farmed salmon stocks. From studies on biochemical genetics they concluded that the natural salmon is divided into genetically distinct populations; sometimes more than one within the

same river system. Farmed salmon (commercial stocks for intensive farming and culture aimed stocks) is not a homogeneous group and it is not possible to distinguish between wild and cultured salmon on the individual level by use of biochemical gene markers.

Potential genetic impact

Skjervold (1988) gave an overview of the types of genetic impact the fish farming could have on natural salmon stocks. In spite of the difficulties in estimating the numbers of escapees from fish farms, and of the magnitude of their contribution to the recruitment of salmon, evidently a great potentiality exists of significant gene transfer risk from farmed salmon to occasional rivers.

The farmed salmon has been subjected to intensive selection for improvement of productive traits, especially improved growth rate and late maturation. Genetic selection is performed systematically through a large scale program on improvement for fish farming conducted by the Fish Farmers Association and the Fish Farmers Sales Organization in Norway. In addition most egg producers make phenotypic selection of broodstock, and probably also seminatural selection as an adaptation to life under farming condition (domestication) has taken place for 4-5 generations. The genotypes of the farmed fish may differ in several respects from the genotype of the population from which they originated several generations ago. It is difficult to predict how this change will affect their adaptation with respect to survival in the natural environment, but escapees which reproduce in rivers chosen by random will always decrease the differentiations between the wild salmon populations.

The origin of the salmon used for fish farming is important. Ståhl (1987) has shown that especially the Baltic salmon differs in genetic composition from the salmon in the north-east Atlantic, and east-Atlantic salmon differs in several aspects from the west-Atlantic stocks. As far as we know there has been no import of west-Atlantic live salmon to Norway (except for scientific purpose), but for several years we have had importations of smolts from Iceland, Scotland and especially from Sweden and Finland (Baltic salmon).

Gjedrem and Aulstad (1974) observed that a strain of Baltic salmon showed much lower resistance to vibrio disease than the Norwegian strains, indicating that genetically differences in resistance to certain diseases exist between geographically distant groups. Escapement of fish with other adaptations to diseases and parasites in the environment will represent a risk for transferring such disease agents to natural population. Thus newly established or potential hybride populations may be eradicated due to spontaneous or accidental disease outbreaks.

Hybridization, hybride vigor and short term adaptation

Crossbreedings of natural and escaped salmon in the rivers are expected to cause increased heterozygosity, which may lead to hybrid vigor for some traits. Hybride vigor most often is found for traits with low heritability (Skjervold 1988), and survival traits have low heritabilities as far as they have been studied (Gjerde 1986). Thus, hybridizing with natural salmon in a river may give the impression of very well adapted fish; an adaptation which may oust nonhybride natural salmon, but last only for the first generation. Altukhov (1981) described a similar case with chum salmon where liberation of non-indigenous fish resulted in very low production both of the introduced fish and of the indigenous fish in the same river.

Genetic drift, reduced genetic variability and low numbers of spawners

Low numbers of spawners (effective population size) will always increase genetic drift, decrease heterozygosity and consequently increase the risk of loss of genes. A number of 100 specimens of each sex is recommended by Allendorf and Ryman (1987) but in several cases of artificial reproduction for enhancement work and intensive fish farming, the spawning populations are considerably less than recommended based on theoretical considerations. However, judged from the results of Ståhl and Hindar (1988) the heterozygosity is higher in artificial than in most natural populations, and the genetic variability within populations is not reduced due to culture activities. This may be due to the fact that cultured populations usually represent different natural populations and contain more genetic variation than any single population. Therefore the risk of

reducing the fitness of salmon through reduced genetic variability does not seem to be serious for the moment, although it should be kept in mind by monitoring both cultured and natural populations through several generations.

In conclusion the escapement of farmed salmon, and liberation of non-indigenous salmon for enhancement work represents a risk of decreasing the genetic variability between populations, possibly also reducing the long time fitness by first generation hybrid vigor in adaptive traits through hybridization between indigenous and non-indigenous fish. For the moment, however, loss of genetic variability through low numbers of broodstock for culture purpose does not seem to represent a risk.

INITIATIVES

To avoid impact of cultured salmon on wild stocks a series of initiatives have been taken or are being planned in Norway. These initiatives are listed below with a statement of the status of each of them.

Technical improvement

In addition to representing a risk for wild salmon, salmon escaping from fish farms always represent a loss for the fish farmer. Improvement of technical facilities to prevent escapement therefore is an immediate initiative to prevent contact between wild and cultured salmon. Usually, the security of a fish farming facility is a compromise between the chance of loss and the cost of investment. Landbased facilities are more safe than ordinary net pens, and closed or semiclosed pens are also an alternative. For the moment, landbased facilities for marine culture are not much used in Norway, but closed or semiclosed systems are under development. No specific demand is required for fish farming devices, but it has been proposed to establish protective areas for salmon where no farming activities will be allowed unless they are secured with respect to escapement. Within the zones technical improvements may prevent contact between natural and farmed salmon.

Gene banks (sperm banks)

Salmon from Gyrodactylus-treated streams are taken care of by artificial breeding and liberation, partly also in intensive culture (Ståhl and Hindar 1988). A sampling program for deep-freezing of sperm is undertaken (Gausen 1986). In 1986 sperm from 48 strains were preserved, while in 1987 the sperm bank increased to contain sperms from 69 populations. By using such sperms, populations which have been eradicated may at least partly be reconstructed. By use of androgenetic techniques more complete natural populations may be reconstructed from sperm banks (Scheerer et al. 1986).

Restriction on transfer of live material

For many years there has been a lack of smolts for the fish farming industry in Norway, as the smolt production did not increase as fast as the development of food fish production. For this reason, some imports have been legislated, in some cases with disastrous results concerning cultured salmon (i.e. import of furunculosis from Scotland) and natural populations (possible import of Gyrodactylus salaris from Baltic countries). In 1988 there was a surplus of smolts in Norway. This situation is expected to persist, and there is no longer any reason for import of live salmon, although even this year (1988) there has been an import of salmon eggs from Iceland. Transport of live material within the country probably also has contributed to the spread of Gyrodactylus. This seems to be a problem especially in cases where salmon farms are situated in fresh water systems also supporting anadromous salmonids, or in brackish water with a salinity lower than 14 to 18 o/oo. For this reason restrictions of transfer within Norway are also proposed, but not yet decided upon.

Use of indigenous fish for enhancement work

Enhancement has been conducted for several years by releasing offspring from occasional salmon of unknown origin, also farmed fish. To protect the between strain variation, in principle now only endemic fish are allowed to be used for enhancement of natural stocks. Only when such fish is unavailable, non-indigenous fish are allowed used.

Areas protected from fish farming

Hatcheries for commercial production of smolts for intensive fish farming are usually not located in or close to rivers with anadromous salmonid populations. However, some existing hatcheries are located close to rivers with sea-run fish, and inland in Norway plants for rainbow trout productions (mostly small) are sometimes located in lakes draining to salmon rivers. Such fish farms have probably spread Gyrodactylus salaris. Hereafter no new installation for intensive production or for enhancement work for other than indigenous populations, will be allowed in rivers supporting anadromous populations.

To protect larger areas, a plan has been formulated for time restricted protective areas for wild salmonids. This plan is now subjected to consideration by involved official agencies and private organizations, and the fate of the proposal is yet uncertain. The aim of the proposal is to protect larger areas and secure references for observation of gene introgression and spread of disease agencies. To prevent further spread of Gyrodactylus salaris no new culture activities will be allowed where this parasite has been found. This include the river drainage and a defined area usually within about 20 km of the river mouths. Usually, rivers having a mean annual catch of more than 500 kgs anadromous salmonids will be protected. A few larger fjord areas (Sognefjorden, Trondheimsfjorden) are also proposed to be held free from new aquaculture installations. Such protective areas are proposed for five years as it is desirable to gain experience about the effect of such restrains before long-lasting decisions are made. If escapement free facilities are constructed, limited farming activities may be allowed, and existing farms within the areas will be allowed to continue.

MONITORING AND RESEARCH

The establishment and increase of the intensive fish farming industry represent a new and possibly serious threat to the natural populations of Atlantic salmon in Norway as well as in several other countries. From a management point of view actions are taken or will be taken to

conserve the natural population in coexistence with the developing fish farming industry, and possible commercial sea ranching activities. A first approximation to such management is to monitor the changes that really take place, and then to develop new methods for interaction studies. Further studies on quantities of escaped reared salmon in coastal areas and in the rivers, studies on infection sources for disease agents, occurrence of disease agents in natural populations and development of methods for defence against parasites (i.e. Gyrodactylus) in natural environment are required. Reconstruction of eradicated (or strongly decreased) natural populations from live gene banks or sperm banks by androgenesis is another area of research and development. Concerning genetic impact, the discussion is often loose and concentrates more on potential impact than on actual facts. To base this discussion on observed or experimental data will be a great challenge for scientific activities in the near future. Further studies on genetic differentiation of natural populations is important. To study hybridization and gene introgression, use of gene markers is a promising method. For other species (cod, brown trout) broodstocks homozygous for specific gene markers (biochemical or morphological) are developed (Skaala *et al.* 1988). No suitable markers are yet found for salmon, but this will be further investigated for application in field studies on interaction between populations. If such studies are difficult or impossible to perform with salmon, they will be performed with brown trout as a model species.

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MEMORANDUM

State of Alaska

DEPARTMENT OF LAW

DATE: July 5, 1988

TO: Hon. Don W. Collinsworth
Commissioner, ADF&G

FILE NO:

~~The~~ Hon. Dick Eliason
Alaska State Senate

TELEPHONE NO:

THRU:

SUBJECT: DeNardo v. State
(mariculture moratorium
challenge)

FROM: Sarah E. McCracken
Assistant Attorney General
Natural Resources-Anchorage

CONFIDENTIAL
ATTORNEY-CLIENT PRIVILEGE

SEM
The Attorney General's office has been served with a complaint filed in the Superior Court by Daniel DeNardo (acting pro per), in which Mr. DeNardo requests the court to issue a judgment declaring that the legislature's extension of the moratorium on finfish farming (ch. 145, SLA 1988) is unconstitutional, in violation of the interstate commerce clause, privileges and immunities clause, and the Fourteenth Amendment, and enjoining enforcement of the "acts of the legislature forbidding issuance of the necessary licenses for salmon farming."

Mr. DeNardo is a fairly well known pro se litigant and has filed numerous actions against various state officials and challenged several statutory provisions, including a current challenge to the Olympic ballot checkoff. The mariculture case has been assigned to Judge Karen Hunt, although I suspect she may recuse herself in light of the fact that Mr. DeNardo filed an action against her for judicial misconduct in 1986.

I expect to file a motion to dismiss the action based on standing in the near future. I will keep you informed on developments in this case. If there is any one else you know of who should be on the distribution list for material relating to this suit, please let me know. Best regards.

SEM/jmo

cc: Larri I. Spengler, AGO JNU

STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES

SOUTHEAST REGIONAL OFFICE
DIVISION OF LAND AND WATER MANAGEMENT

STEVE COWPER, GOVERNOR

400 WILLOUGHBY AVENUE
SUITE 400
JUNEAU, ALASKA 99801-1000
PHONE: (907) 465-3400

June 19, 1989

Dear Interested Alaskan:

Please find enclosed a copy of the Department of Natural Resources's aquatic farm regulations. The regulations will be effective on July 1, 1989 and will govern how the department accepts and processes aquatic farm applications.

Please contact me at the above address or phone number if you have questions.

Sincerely,


Janet Burleson
Project Coordinator

Enclosure

TITLE 11. NATURAL RESOURCES.

Part 1. Office of the Commissioner (11 AAC 03--11 AAC 06)

Part 6. Lands (11 AAC 52--11 AAC 98)

PART 1. OFFICE OF THE COMMISSIONER.

Chapter

05. Fees for Department Services (11 AAC 05.010--11 AAC 05.900)

CHAPTER 05. FEES FOR DEPARTMENT SERVICES.

Section

010. Fees

11 AAC 05.010. FEES. (a) Non-refundable fees to apply for authorizations and fees to obtain publications or services from the department are as follows:

(6) surface leasing

(K) application for aquatic farmsite permit or lease; for amendment or renewal of aquatic farmsite permit; or for amendment, extension, or assignment of aquatic farmsite lease, \$50;

(Eff. 1/1/86, Register 96; am 8/10/86, Register 99; am 9/28/86, Register 99; am 8/23/87, Register 103; am 1/28/88, Register 105; am 7/1/89, Register 110)

Authority: AS 03.10.020
AS 27.21.030
AS 38.05.020
AS 38.05.035
AS 38.05.295
AS 38.05.856
AS 38.09.110
AS 38.35.020
AS 38.35.050
AS 38.50.160

AS 38.95.240
AS 41.06.020
AS 41.21.020
AS 41.21.026
AS 44.17.030
AS 44.37.020
AS 44.37.025
AS 45.50.315
AS 46.15.020

PART 6. LANDS.

Chapter

63. Aquatic Farmsite Permits and Leases (11 AAC 63.010--11 AAC 63.900)

11 AAC is amended by adding a new chapter to read:

CHAPTER 63. AQUATIC FARMSITE PERMITS AND LEASES.

Section

- 010. Applicability; aquatic farmsite permit defined
- 020. District application periods
- 030. Aquatic farmsite permit applications
- 040. Associated facilities; upland owner preference right; upland owner access right
- 050. Application review; best interest finding
- 060. Notice and opportunity to comment
- 070. Aquatic farmsite permit
- 080. Required security
- 090. Transition; permits under AS 38.05.850
- 100. Aquatic farmsite lease
- 110. General permit and lease provisions
- 900. Definitions

11 AAC 63.010. APPLICABILITY; AQUATIC FARMSITE PERMIT DEFINED. (a) This chapter covers aquatic farmsite permits issued under AS 38.05.856 and leases issued under AS 38.05.083 for the development and operation of an aquatic farm or related hatchery, as those terms are defined in AS 16.40.199. An aquatic farmsite permit or lease will, in the commissioner's discretion, be issued for tideland, submerged land, and shoreland managed by the department under AS 38, but will not include land within a state park or other land that has been withdrawn from the state public domain. The aquatic farmsite authorization will, in the commissioner's discretion, include authorization for associated storage and housing facilities, including facilities on adjacent

upland managed by the department under AS 38, in accordance with 11 AAC 63.040.

(b) Issuance of an aquatic farmsite permit is a disposal of an interest in state land. An aquatic farmsite permit is revocable only for breach of its provisions. It conveys the exclusive, non-transferable right, during a three-year term, to improve and develop the site as an aquatic farm or related hatchery in accordance with the permit's provisions, and includes a preference right to an aquatic farmsite lease if the permittee develops the site for aquatic farming or related hatchery operations in accordance with the permit's provisions.

(c) A person who only wants to test a site's suitability for aquatic farming, without developing it or acquiring any property right, may be authorized to do so in accordance with 11 AAC 63.090(e)(1). A person who wants to acquire property rights so that he or she can develop the site into an aquatic farm may do so by applying for an aquatic farmsite permit, in accordance with 11 AAC 63.030, during the application period for that district. The applicant might be eligible for a preference right if the applicant is already lawfully operating an aquatic farm (11 AAC 63.090(a)) or is an upland owner or lessee (11 AAC 63.040(f)). A preference right is not an entitlement to receive the authorization, but it protects the applicant against some or all competition for it. If the applicant receives an aquatic farmsite permit and successfully develops the site as mentioned in (b) of this section, the permittee has a preference right to lease the site. No one else may apply for the aquatic farmsite lease, nor may anyone apply directly for a lease without first obtaining an aquatic farmsite permit. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.083
AS 38.05.855
AS 38.05.856

11 AAC 63.020. DISTRICT APPLICATION PERIODS. (a) The commissioner will prepare a fixed schedule of the dates on which aquatic farmsite permit applications may be filed in a district. The schedule will be available to the public.

(b) The commissioner will give notice that a district is open to aquatic farmsite permit applications by publication, beginning before the application period opens, in at least one newspaper of statewide circulation and one newspaper of general circulation in the district. If a preapplication conference is scheduled under 6 AAC 50.040 so that potential applicants and other interested persons can discuss their plans and exchange information about the district, notice of the conference will be included.

(c) The commissioner will, in his or her discretion, set application filing guidelines for a district, such as minimum or maximum size limits for aquatic farmsites, minimum distances from anchorages or the mouths of anadromous fish streams, or a limit on the total number of applications that a person may file, or permits that a person may hold, in that district. Filing guidelines will be available at the places listed in the public notice announcing the application period.

(d) Maps of a district that is open to aquatic farmsite permit applications will be available at the places listed in the public notice announcing the application period. To the extent practical, the map will indicate areas known to be unavailable or unsuitable for aquatic farmsite permits. For example, an area might be unavailable because it is already subject to aquatic farmsite authorizations or because aquatic farming is prohibited by an applicable zoning ordinance, district coastal management program, or state land use plan. An area might be unsuitable if the Department of Environmental Conservation determines that known water pollution is incompatible with raising shellfish and aquatic vegetables for human consumption. The map will also indicate areas where aquatic farming is discouraged, but not prohibited outright, by a state land use plan. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.855
AS 38.05.856

11 AAC 63.030. AQUATIC FARMSITE PERMIT APPLICATIONS. (a) An aquatic farmsite permit application is subject to 11 AAC 67.007, except that it may be filed only at the regional office responsible for the relevant district. The application must

- (1) be submitted on a form approved by the commissioner;
- (2) include the non-refundable application fee required by 11 AAC 05.010;
- (3) include a clear scaled drawing of the site boundaries on a U.S.G.S. map at a scale of 1:63,360 or a navigation chart, as required by the application form;
- (4) be accompanied by a completed coastal project questionnaire as required by 6 AAC 50, unless the application is solely for shoreland outside the coastal zone; and
- (5) comply with all application filing guidelines set under 11 AAC 63.020(c), except that the applicant may request a waiver of a filing guideline that sets a maximum size limit; the

commissioner will, in his or her discretion, waive the size limit if (A) the applicant shows that a waiver is justified by the applicant's experience, capitalization, and need for a larger site in order to form an economic unit and (B) the commissioner, after considering the reason for which the size limit was imposed and public comment on the proposed waiver, determines that the waiver is in the state's best interest; the commissioner's proposal to waive the size limit will be included in the preliminary finding under 11 AAC 63.050.

(b) Each application must include sufficient detail on the applicant's proposed site improvements to allow the commissioner to determine the amount of the security required under 11 AAC 63.080. It must also include a proposed development plan and schedule. The development plan and schedule must result in reasonable use of the site and must ensure that the site is developed for aquatic farming or related hatchery operations before the permit expires. The commissioner will, in his or her discretion, approve the development plan and schedule, or amend it as the commissioner considers necessary to make reasonable use of the site. The application may include both a minimum and maximum development plan and schedule; if both are approved, fulfilling the minimum development plan and schedule will fulfill the development requirement, and the permittee may operate at any higher level up to the maximum development plan and schedule without the need for an amendment.

(c) An applicant may file as many non-overlapping applications as desired, unless the commissioner has limited the number by setting a filing guideline under 11 AAC 63.020(c).

(d) Except as provided in 11 AAC 63.040(f) and 11 AAC 63.090(b), all complete applications received during a district application period are considered to have been simultaneously filed. If the number of applications filed for a particular area exceeds the number of sites that the commissioner decides to grant, the commissioner will hold a lottery to draw the proper number of applications.

(e) If two applications overlap in an area where the commissioner does not propose to limit the number of authorized sites, the applicants will be granted 30 days to agree on amendments that eliminate the overlap. If an application overlaps an existing aquatic farmsite permit or lease, or a mariculture testing or development site subject to a preference right under 11 AAC 63.090(a), the applicant will be granted 30 days to amend the application so as to eliminate the overlap. The commissioner will, in his or her discretion, amend an application

(1) to eliminate an overlap if the applicant has failed to do so, or

(2) to eliminate or reduce other site or resource use conflicts. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.855
AS 38.05.856

11 AAC 63.040. ASSOCIATED FACILITIES; UPLAND OWNER PREFERENCE RIGHT; UPLAND OWNER ACCESS RIGHT. (a) The commissioner will, in his or her discretion, authorize associated facilities for storing equipment or housing personnel at an aquatic farmsite, including upland managed by the department under AS 38, if the commissioner is satisfied that the associated facilities are necessary for aquatic farming. An applicant who wants authorization for associated facilities at either the permit or lease stage must request it as part of the permit application so that it can be considered during agency and public review.

(b) The conditions in this subsection apply to an authorization for personnel housing at an aquatic farmsite during the permit stage, but not at the lease stage. The commissioner will authorize such housing only if the applicant shows that (1) the level of site development at the time the housing is expected to begin will require that personnel be present on a daily basis, (2) the personnel cannot reasonably commute to the site by road, boat, or aircraft on a daily basis, and (3) no nearby land suitable for housing is available for rent or sale. The housing facility may not be used as the personnel's primary or full-time residence. It must be designed and constructed so that it can be removed and the site completely restored within 30 days if the permit terminates or if housing personnel at the aquatic farmsite ceases to be necessary. The housing facility may not be placed on a permanent foundation, except that a foundation of wooden pilings may be used if the applicant agrees either to remove the pilings or to cut them off at ground level if site restoration is required.

(c) The conditions in this subsection apply to an authorization for floating housing at an aquatic farmsite during either the permit or lease stage. The commissioner will authorize floating housing only if that use is consistent with the floathouse provisions and management intent of an applicable land use plan, zoning ordinance, or coastal management program, and if the Department of Environmental Conservation determines that such housing would not result in degraded water quality that would be incompatible with raising shellfish or aquatic vegetables for human consumption.

(d) The nature and extent of associated facilities are a factor in setting the security amount under 11 AAC 63.080, setting the fee for an aquatic farmsite permit under 11 AAC 63.070, and appraising the fair market value of a lease under 11 AAC 63.100.

(e) After a permit or lease terminates, the former permittee or lessee has no entitlement or preference right to continue using or occupying any portion of the aquatic farmsite, including anchoring a floathouse at the site.

(b) Under this subsection, the commissioner grants an aquatic farmsite permit preference right to eligible upland owners and lessees in order to increase the compatibility of aquatic farming with upland management policies. The owner or lessee of adjacent or nearby upland may request a preference right to an aquatic farmsite permit by agreeing to place his or her associated facilities for storing equipment or housing personnel on his or her own land or leasehold rather than on state-owned land or other public land. The following apply to a preference right under this subsection:

(1) For an upland owner or lessee to be eligible, the applicant's development plan and schedule must demonstrate that the associated facilities are necessary for aquatic farming.

(2) For an upland lessee to be eligible, the term of the upland lease must equal or exceed the combined terms of an aquatic farmsite permit and lease. A U.S. Forest Service special use permit does not constitute a leasehold interest that would make the holder eligible for a preference right under this subsection.

(3) A preference right granted under this subsection is secondary to a preference right that the commissioner grants under 11 AAC 63.090(a).

(4) If the number of applications eligible for an upland owner/lessee preference right exceeds the number of permits that the commissioner decides to grant, the commissioner will hold a lottery as set out in 11 AAC 63.030(d) among the preference-eligible applications only.

(5) An upland owner or lessee who wants a preference right for aquatic farming must apply under this subsection, rather than under AS 38.05.075(c). AS 38.05.075(c) does not give an upland owner or lessee any entitlement or preference right to an aquatic farmsite permit or aquatic farmsite lease.

(c) No aquatic farmsite permit or lease will be issued that would deny an upland owner's right of reasonable access to tidewater or deny access by boat to privately owned upland. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.083
AS 38.05.855
AS 38.05.856

11 AAC 63.050. APPLICATION REVIEW; BEST INTEREST FINDING.

(a) After an aquatic farmsite permit application period closes, complete applications will undergo review by agencies and affected coastal districts in accordance with 6 AAC 50.070 for consistency with the Alaska Coastal Management Program. Compliance with this requirement fulfills the agency consultation requirement of AS 38.05.855(c). Comments received will be considered both for the coordinating agency's proposed consistency determination and for the commissioner's preliminary best interest finding. If applications are filed for sites within a state game refuge or critical habitat area, the commissioner will request the approval of the commissioner of the Department of Fish and Game as required by AS 16.20.060 or 16.20.530.

(b) The commissioner will prepare a preliminary best interest finding that proposes sites for which permits may be issued. If the sites are unclassified, a proposed land use plan and classification order will be prepared, and might accompany or be included as part of the preliminary best interest finding. If the commissioner decides to deny an application, to require its amendment, or to limit the number of sites to be authorized, the finding will explain the reason. The finding will consider both advantages and disadvantages of the proposal. Criteria that will be considered in the finding include:

(1) whether the Department of Fish and Game considers the proposed aquatic farm or hatchery to meet the criteria of AS 16.40.105;

(2) whether the Department of Environmental Conservation determines that the proposed aquatic farmsite is protected from pollution from adjacent floating and upland support activities, to ensure product wholesomeness, and that effective pollution control measures can be implemented to protect land and water at the site from pollution caused by the proposed aquatic farm or hatchery;

(3) whether the coordinating state agency proposes to find the proposed aquatic farm or hatchery consistent with the Alaska Coastal Management Program;

(4) whether aquatic farming is compatible with official land management policies applicable to the proposed aquatic farm site and nearby upland, including legislative or congressional designations such as parks or wilderness areas and adopted federal, state, and local land use plans, land classifications, and zoning;

(5) whether aquatic farming conflicts with existing uses, or with pending uses, as that term is defined in 11 AAC 63.900, of the site and of nearby land, whether or not the nearby land is in state ownership, including consideration of

(A) impacts on nearby communities or residential land;

(B) traditional and existing uses of the site, including commercial fishing, sport fishing, subsistence activities, use as a primary anchorage, navigation, seaplane landing area, recreation, sightseeing, and tourism; consideration of this criterion will, in the commissioner's discretion, be combined with a traditional use finding if such a finding is required by AS 38.05.830;

(C) historic and cultural resources;

(D) commercial or industrial facilities, such as log transfer facilities, salmon hatcheries, seafood processing plants, or harbor development, that would be incompatible with aquatic farming;

(6) how public access to and along public waters, and the upland owner's right of reasonable access to tidewater, will be ensured by reserving easements under 11 AAC 53 or by other means; if upland access to the water is limited to a specific point by topography, existing improvements, or other factors, the commissioner will ensure that aquatic farming facilities do not obstruct water access to that point;

(7) how the interests served by the public trust doctrine, specifically the public's right to use navigable waters and the land beneath them for navigation, commerce, fishing, and other purposes, will be protected;

(8) whether special permit provisions or other measures are needed to mitigate identified conflicts; for this purpose the commissioner will consult guidelines set out in an applicable land use plan, zoning ordinance, or coastal management program, or, if no such document or guidelines exist or if it would otherwise be appropriate, will consult the guidelines set out on pp. 80-85 of the final 1988 Etolin Island Area Mariculture Pilot Project;

(9) other significant social, economic, and environmental effects of the proposed aquatic farming.

(c) In general, the commissioner will not grant aquatic farmsite permits that would encumber more than a third of the surface area estimated to exist at mean lower low water of a bay, bight, or cove, unless the commissioner finds that (1) it is in the state's best interest to concentrate permits in one such bay, bight, or cove so as to keep other specified water bodies completely unencumbered, (2) the cumulative impacts will not be excessive, and (3) the upland owner will retain a right of reasonable access to tidewater. Such a finding will be included in the best interest finding, as well as in the land use plan if one is being prepared. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.035
AS 38.05.127
AS 38.05.128
AS 38.05.855
AS 38.05.856

Editor's note: Pages 80-85 of the 1988 Etolin Island Area Mariculture Pilot Project, referred to in 11 AAC 63.050(b), may be obtained from DNR, Division of Land and Water Management, at either the Southcentral Regional Office (P.O. Box 107005, Anchorage, Alaska 99510-7005) or the Southeastern Regional Office (400 Willoughby Ave., Juneau, AK 99801).

11 AAC 63.060. NOTICE AND OPPORTUNITY TO COMMENT. (a) Notice under AS 38.05.945 that the preliminary best interest finding is available for written comment will, in the commissioner's discretion, be combined with notice of the time, place, and location of a hearing to be conducted under AS 38.05.946(b); notice of a proposed determination of consistency with the Alaska Coastal Management Program; notice of a proposed land use plan and classification, if the land is not yet classified; and notice of the approximate date when the final best interest finding, as well as the final land use plan, if required, is expected to be available.

(b) The commissioner will conduct the public hearing that AS 38.05.946 requires in each district either in person or by teleconference.

(c) The department will maintain a mailing list of persons who ask in writing to receive notice of district openings and

notice of comment opportunities. Any interested person may ask inwriting to be put on an aquatic farming mailing list. The department will use the mailing list to notify recipients of opportunities for public comment and involvement such as the opening of a district application period or the availability of a preliminary best interest finding.

(d) If the upland adjacent to an aquatic farmsite permit application is not managed by the department, the commissioner will notify the upland owner of the opportunity to comment under (a) of this section. If an aquatic farmsite permit applicant states that using upland for associated facilities is necessary for aquatic farming, and the upland owner notifies the commissioner in writing that the owner cannot or will not authorize the upland use, the commissioner will not grant the aquatic farmsite permit.

(e) Decisions made as a result of public and interagency comment will be incorporated into the final best interest finding and, if required, into the final land use plan. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.855
AS 38.05.856
AS 38.05.945
AS 38.05.946

11 AAC 63.070. AQUATIC FARMSITE PERMIT. (a) The commissioner will grant an aquatic farmsite permit to a successful applicant after the commissioner issues the final finding required by AS 38.05.035(e) and AS 38.05.855(d) and the coordinating state agency issues a conclusive determination of consistency with the Alaska Coastal Management Program.

(b) Within 30 days after receiving the permit, the applicant shall sign it and return it to the commissioner along with

(1) the security required by 11 AAC 63.080; and

(2) a use fee, set in a fee schedule approved by the commissioner, to provide the state a reasonable return for the permittee's use of the site, but less than the fair market value rent.

(c) An aquatic farmsite permit is subject to the provisions set out in this section in addition to the general provisions of 11 AAC 63.110.

(d) A permit might be also subject to special provisions that the commissioner imposes to make it consistent with the Alaska Coastal Management Program or that the commissioner otherwise considers necessary to serve the state's best interests.

(e) The aquatic farm development plan and schedule proposed in the application, as approved or amended by the commissioner, is incorporated as a provision of the permit.

(f) A permit will, in the commissioner's discretion, be cancelled, in whole or in part, if the permittee obtained it improperly through misrepresentation or error with respect to material facts.

(g) A permittee may apply for no more than two renewals of a permit, for an additional three years for each renewal. A new written finding is not required before the commissioner renews a permit. The commissioner will renew a permit if the commissioner is satisfied, based on information submitted by the permittee and testimony provided by interested persons after notice under AS 38.05.856 and notice to the upland owner, that

(1) the permittee is in substantial compliance with the permit's provisions and is in operation, or

(2) the permittee is in substantial compliance with the permit's provisions except that the permittee is not in operation, and that the failure to comply with the aquatic farm development plan and schedule and to begin operating is due to circumstances beyond the permittee's control. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.035
AS 38.05.850
AS 38.05.855
AS 38.05.856

11 AAC 63.080. REQUIRED SECURITY. For any aquatic farmsite permit or lease, a bond, cash deposit, certificate of deposit, or other form of security acceptable to the commissioner must be posted and maintained in an amount determined by the commissioner to be sufficient to cover the cost of site cleanup and restoration and any associated cleanup costs. Factors that the commissioner will use in determining the amount of the security include travel costs to reach the site for cleanup or inspection; the planned size and extent of improvements; whether the improvements (including associated facilities on state land) could be towed away for use by other operators, burned onsite, or disposed of at an authorized landfill; and whether heavy equipment would be needed for upland site restoration and filling a foundation excavation. The commissioner will, in his or her discretion,

subsequently change the amount of the required security, based on changes in the level of site development, new information, or other appropriate factors. The commissioner will, in his or her discretion, reduce the amount of the security if the property is subject to a collateral assignment as security for financing and the collateral assignee agrees to assume the permittee's or lessee's obligations and restore the site if the permittee or lessee defaults. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.035
AS 38.05.083
AS 38.05.856

11 AAC 63.090. TRANSITION; PERMITS UNDER AS 38.05.850. (a) If the commissioner finds that it is in the state's best interest to issue an aquatic farmsite permit, a person who has a permit in good standing that was issued under AS 38.05.850 for mariculture testing or development purposes has a preference right to the aquatic farmsite permit if

(1) as of June 9, 1988, the person was either lawfully operating an aquatic farm at that site, or had obtained and was complying with all permits necessary to operate an aquatic farm at that site and, in reliance on those permits, had undertaken the initial steps that would lead to full-scale operations; photographs, purchase orders, receipts, or other evidence acceptable to the commissioner must be provided to establish eligibility; and

(2) the person files a complete application for the site during the appropriate district application period.

(b) An application filed by a person who has a preference right to the site under (a) of this section is exempt from the amendment procedures of 11 AAC 63.030(e) and the lottery procedures of 11 AAC 63.030(d).

(c) A person who has a permit issued under AS 38.05.850 but who does not otherwise meet the requirements of (a) of this section does not have a preference right to an aquatic farmsite permit that might be issued for the site. However, the person may apply for an aquatic farmsite permit on a non-preference-right basis. If another person is chosen as the successful applicant, or if the commissioner decides that it is not in the state's best interest to grant an aquatic farmsite permit for the site, the commissioner will revoke the permit issued under AS 38.05.850 after reasonable notice to the permittee.

(d) A permit in good standing that was issued under AS 38.05.850 to a person who might have a preference right under (a) of this section will be renewed until the site is included in a district application period. In the interim, the permittee may continue operating so long as all required permits remain in good standing and no change of use occurs.

(e) Except as follows, no new permit will be issued under AS 38.05.850 for aquatic farming purposes unless the applicant filed a complete application before June 9, 1988:

(1) A person may obtain a permit under AS 38.05.850 solely to test a site's suitability for aquatic farming or, to the extent allowed by 11 AAC 96, may undertake such testing without a permit from the department. A permit for testing site suitability under AS 38.05.850 is limited to a period of no more than one year and the total area within which testing occurs may not exceed one acre. Testing includes placing data collecting equipment and up to 10,000 organisms in the water. The organisms may not be used for commercial purposes. A permit under AS 38.05.850 for testing site suitability may not be renewed.

(2) In an emergency, such as a dinoflagellate plankton bloom that could result in an unacceptable concentration of toxins in shellfish, the director will use his or her discretion under AS 38.05.850 to authorize the relocation of rafts or other rearing structures to another location until the emergency ends. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.083
AS 38.05.850
AS 38.05.855
AS 38.05.856
Sec. 18, ch.
145, SLA 1988

11 AAC 63.100. AQUATIC FARMSITE LEASE. (a) If the commissioner finds in accordance with AS 38.05.035(e) that it is in the state's best interest to issue an aquatic farmsite lease, an aquatic farmsite permittee who has developed the site for aquatic farming or related hatchery operations in accordance with the permit's provisions has a preference right to lease the site at its appraised fair market value without competitive bid. A person who does not have an existing aquatic farmsite permit may not apply for an aquatic farmsite lease.

(b) An aquatic farmsite permittee who has not succeeded in developing the site for aquatic farming or related hatchery operations does not have a preference right to any lease that may be offered for that site. However, if the commissioner offers the

lease at public auction, the unsuccessful permittee may bid for the lease. The commissioner will offer a former permit site for lease at public auction only if the former aquatic farmsite permittee does not qualify for a preference right or chooses not to exercise the preference right. (c) The term of an aquatic farmsite lease is 10 years. If the lessee applies for an extension before the lease's last day, the commissioner will, in his or her discretion, extend the term for an additional 10 years. The commissioner will, in his or her discretion, require a lease diagram before issuing the lease. Before the commissioner extends a lease, the commissioner will determine whether AS 38.04.045 or a successor statute requires a cadastral survey. If AS 38.05.102 or a successor statute is still in effect when the lease expires, the lessee may apply for a new lease in accordance with that statute.

(d) Before a lease is issued, security must be posted as required by 11 AAC 63.080.

(e) Unless the commissioner grants a variance for good cause, the lessee shall continue to operate the aquatic farm or related hatchery at or above the operating level reached when the permittee applied for the lease. For a lease offered at auction, the commissioner will either impose a minimum lease operating level or require the bidder or lessee to propose a lease operating plan for the commissioner's approval.

(f) A lease that is in good standing may, with the approval of the director, be assigned. The assignee shall promptly and diligently seek to obtain all permits necessary for lawful operations.

(g) Lease rental must be paid annually on or before the anniversary date of the lease. (Eff. 7/1/89, Register 110)

Authority: AS 38.04.045
AS 38.05.020
AS 38.05.035
AS 38.05.083
AS 38.05.856
AS 38.05.920

11 AAC 63.110. GENERAL PERMIT AND LEASE PROVISIONS. An aquatic farmsite permit or lease will contain at least the following provisions:

(1) A permittee or lessee shall operate so as to cause no significant damage to land, public trust resources, and public uses of public trust resources.

(2) A permit or lease is subject to all applicable federal, state, and local law, including statutes and regulations in effect on its effective date; statutes and regulations placed in effect after its effective date, to the extent constitutionally permissible; and the public trust doctrine regarding the public's right to use navigable waters and the land beneath them for navigation, commerce, fishing, and other purposes.

(3) A permittee or lessee shall obtain and remain in compliance with all other federal, state, and local authorizations necessary for lawful operations.

(4) The commissioner will, in his or her discretion, after the application fee required by 11 AAC 05.010 has been paid, amend a permit or lease to change the species of shellfish or aquatic plant being raised or to change the boundary or acreage of the aquatic farmsite, or the number of rafts or other rearing structures authorized, if the change is minor and does not increase obstructions to navigation or to other public use. However, no change of use, as that term is defined in 11 AAC 63.900, will be authorized. Amendment of an aquatic farmsite permit or lease does not relieve the permittee or lessee of the obligation to obtain other necessary authorizations.

(5) A permittee or lessee and its invitees may not use an aquatic farmsite for any unlawful purpose.

(6) A permittee or lessee may use an aquatic farmsite only for the purposes authorized by the permit or lease, and the state reserves all other interests in the site. The rights granted by the permit or lease must be exercised in a manner that does not unreasonably interfere with the rights of the state or of its permittees, lessees, or grantees, consistent with the principle of reasonable concurrent uses as set out in art. VIII, sec. 8, of the Alaska Constitution. A permittee or lessee shall pay for any damages that are payable by reason of the permittee's or lessee's failure to comply with the requirements of this paragraph.

(7) A permittee or lessee shall comply with the approved development plan and schedule or the approved lease operating level.

(8) A permittee's or lessee's failure to timely perform its obligations under the permit, or otherwise to comply with all express or implied provisions of the permit, constitutes a default. If a permittee or lessee fails to cure the default or to begin and diligently continue to remedy the default within 30 days after written notice of the default and an opportunity to be heard, the commissioner will order suspension of site development

or operations until compliance is achieved, or will take other action that the commissioner finds appropriate, including revocation of the permit or lease or attachment of the site restoration security.

(9) With the commissioner's written consent, a permit or lease that is in good standing may be relinquished. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.035
AS 38.05.083
AS 38.05.085
AS 38.05.855
AS 38.05.856

11 AAC 63.900. DEFINITIONS. (a) In this chapter,

(1) "aquatic farm" has the meaning given in AS 16.40.199;

(2) "aquatic farmsite permit" means a property right to improve and develop state-owned public domain land as an aquatic farm or related hatchery;

(3) "aquatic farmsite lease" means a lease to operate an aquatic farm or related hatchery on state-owned public domain land;

(4) "change of use" means (A) a change from one species of shellfish to a species other than shellfish, or from one species of aquatic plant to a species other than aquatic plants, (B) a change in the location of the aquatic farmsite, (C) a significant increase in the aquatic farmsite's acreage, or (D) a significant increase in the surface area of the farmsite that is encumbered by rafts or other rearing structures;

(5) "commissioner" means the commissioner of the Department of Natural Resources or the commissioner's delegate;

(6) "department" means the Department of Natural Resources;

(7) "director" means the director of the division of lands or the director's delegate;

(8) "good standing" means being in compliance with all provisions of all required authorizations;

(9) "pending use" means a project documented by government agency plans or authorizations, the acquisition of property rights, or other evidence of investment-backed expectations that the use will occur;

(10) "primary anchorage" means a large or heavily used anchorage, or an anchorage for which there is no reasonable alternative with comparable protection from locally prevailing weather conditions.

(b) In this chapter and in AS 38.05.083, "developed for aquatic farming or related hatchery operations" means that all planned capital improvements are in place and functioning at their planned capacity to produce aquatic plants or shellfish; however, the aquatic plants or shellfish need not be marketed or have reached marketable size in order to fulfill the development requirement. (Eff. 7/1/89, Register 110)

Authority: AS 38.05.020
AS 38.05.083
AS 38.05.085
AS 38.05.855
AS 38.05.856
AS 38.05.920
AS 38.05.945
AS 38.05.946
Sec. 18, ch.
145, SLA 1988



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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THE LATEST DEVELOPMENTS IN WEST EUROPEAN AND CANADIAN FISHERIES
(MARCH 1989)

The Branch of Foreign Fisheries Analysis, Office of International Affairs, which follows trends in world fisheries for the National Marine Fisheries Service (NMFS), NOAA, has prepared the following summary of recent significant fishery developments in Western Europe and Canada. This report was prepared by William B. Folsom and Brian D. McFeeters with the assistance of U.S. Foreign Service posts in Western Europe and Canada.

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I. EUROPE:

U.S. Fishery Trade, 1988 — The United States imported 163,600 metric tons (t) of fishery products worth \$2.4 billion from all the nations of Europe (including Eastern Europe and the Soviet Union) in 1988. U.S. exports to Europe were 156,000 t valued at only \$0.3 billion. (WF: U.S. Bureau of the Census)

II. EUROPEAN COMMUNITY (EC)

A. General

EC Fleet Reduction — The EC Fisheries Commission is planning to lift a freeze on the construction of new fishing vessels among EC Member States. This action comes despite the fact that only two countries (Denmark and Portugal) met their commitments to reduce the capacity of their fishing fleets in 1987. It also comes at a time when quotas for many countries (and species) are being reduced. (WF: Fishing News International, January 1989).

EC in South America — The EC has initiated a major new effort to expand its influence in South America. The EC has signed a \$10 million program with Peru, Ecuador, and Colombia to develop and expand their fisheries. The program will involve many phases of fisheries development and training. Details on the benefits that will go to the EC were not reported, but the EC is interested in finding new fishing grounds for its fleet. (WF: Fishing News International, January 1989)

See page 2



Icelandic Fish to Japan — Flying Tigers, a U.S. air cargo firm, has started using Iceland as a refueling stop on its flight from Europe to Japan. An Icelandic firm, Flugfax, has been established to sell cargo space on Flying Tigers; the firm hopes to ship as much as 200 t of fish (or other products) a week if the market for Icelandic products justifies additional flights. The first shipment from Iceland, on January 10, 1989, consisted of 3 t of herring, salmon, and haddock—all less than 24 hours old. Exporters hope that Japan will offer a market for products that are not popular in Iceland or in its traditional markets, including monkfish heads and cheeks and fish livers. It also hopes to expand sales of fresh, farm-raised salmon. (WF: U.S. Embassy, Reykjavik, February 7, 1989)

Norway's Arctic Cod — Norwegian scientists have estimated that the Arctic cod stock is at its lowest level in the past 120 years. Norwegian scientists believe that the total 1989 stock is 855,000 t versus 1,400,000 t in 1988 and estimate the spawning stock at only 187,000 t. Scientists say that the spawning stock could reach 400,000 t by 1991, if steps are taken immediately to protect it. Scientists would like to set the Arctic cod TAC at 300,000 t for 1989. (WF: Fishing News International, January 1989)

Norway Targets UK — Norway is launching a major offensive to increase exports of fresh and frozen fishery products in the UK in 1989. Norway increased its exports to the UK by 50 percent in 1988 (to 9,500 t worth \$55 million) and hopes to sharply increase these figures in 1989. The UK purchased 2,155 t of fresh and frozen Norwegian salmon worth \$17 million (44 percent higher than in 1987). Sales of frozen demersal fillets averaged about 30,000 t and shrimp exports rose from 2,700 t to 3,600 tons. Weekly shipments of fresh fish by truck and ferry, and a newly introduced fast catamaran service from Norway to the UK have helped expand sales. (WF: Fishing News, February 10, 1989)

Norwegian Farmed Salmon Escaping — An estimated 1 million farmed salmon have escaped from fish farms along Norway's coast during the 1988/89 winter, prompting concern among fisheries scientists that the wild salmon gene pool may become irreparably damaged. There are many breeds of Norwegian wild salmon, each of which returns to spawn in a specific river. Fisheries scientists fear that interbreeding with farmed salmon could upset genetic characteristics of wild salmon which have taken thousands of years to evolve—including the innate ability of salmon to find their way back to the river where they were spawned. (EM: Norinform, February 14, 1989)

Norwegians Fight Fish Lice — Norwegian salmon farmers are conducting tests to determine whether small wrasses can improve the health of pen-raised salmon. Preliminary tests indicate that fewer than 1,000 labrid fishes (such as gold sinny, a member of the wrasse family indigenous to Norway) can protect a pen of 26,000 salmon fry from salmon lice. Such parasite infestations have previously been prevented using medication. If tests prove successful, use of the small fish may replace chemical treatment of farmed salmon. (EM: Norinform, February 14, 1989)

Alaska Department of Fish & Game
GENETIC POLICY

by

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INTRODUCTION

Alaska's valuable salmon industry relies on production from wild systems and, increasingly, on fish produced by aquaculture programs. The importance of maintaining healthy wild stocks and implementing successful enhancement activities underlies the need for an effective genetic policy. The genetic guidelines created to steer Alaska's aquaculture efforts were established in the mid-70's and have been reviewed to ensure that they reflect current knowledge, and goals. A revised genetic policy has been established that contains guidelines, supporting information and recommendations.

The genetic policy contains restrictions that will serve to protect the genetic integrity of important wild stocks. Certainly in Alaska where wild stocks are the mainstay of the commercial fishery economy, it is necessary to protect these stocks through careful consideration of the impacts of enhancement activities. Another important aspect of the genetic policy is the orientation towards increasing the productivity of enhancement programs in the state. Adherence to the guidelines will help maintain adequate genetic variability ensuring that the enhanced stock will be able to adapt to changing environmental conditions. The policy also includes considerations for selective breeding for desirable characteristics.

Due to the limited amount of information available on the genetic impacts of salmon enhancement on wild stocks, much of the basis for these guidelines is theoretical or based on work done with other species. Consequently, the most important considerations used in writing the guidelines are presented as a mechanism for illustrating the intent of the policy. An understanding of the rationale behind the policy is imperative to its effective application to individual cases under the very diverse conditions found in Alaska.

The importance of the genetic guidelines will continue to increase as aquaculture activities expand their production. This policy represents a consensus of opinion and should continue to be periodically reviewed to ensure that the guidelines are consistent with current knowledge. By doing so, we will be able to meet the goal of greater fish production through enhancement while maintaining healthy wild stocks.

POLICY STATEMENT

I. Stock Transport

- A. Interstate: Live salmonids, including gametes, will not be imported from sources outside the state. Exceptions may be allowed for trans-boundary rivers.
- B. Inter-regional: Stocks will not be transported between major geographic areas: Southeast, Kodiak Island, Prince William Sound, Cook Inlet, Bristol Bay, AYK and Interior.
- C. Regional: Acceptability of transport within regions will be judged on the following criteria.
 - 1. Phenotypic characteristics of the donor stock must be shown to be appropriate for the proposed fish culture regions and the goals set in the management plan.
 - 2. No distance is set or specified for transport within a region. It is recognized that transplants occurring over greater distances may result in increased straying and reduce the likelihood of a successful transplant. Although the risk of failure affects the agency transporting the fish, transplants with high probability of failure will be denied. Proposals for long distance transport should be accompanied by adequate justification for using nonlocal stock.

II. Protection of Wild Stocks

- A. Gene flow from hatchery fish straying and intermingling with wild stocks may have significant detrimental effects on wild stocks. First priority will be given to protection of wild stocks from possible harmful interactions with introduced stocks. Stocks cannot be introduced to sites where the introduced stock may have significant interaction or impact on significant or unique wild stocks.
- B. Significant or unique wild stocks must be identified on a regional and species basis so as to define sensitive and nonsensitive areas for movement of stocks.
- C. Stock Rehabilitation and Enhancement
 - 1. A watershed with a significant wild stock can only be stocked with progeny from the indigenous stocks.
 - 2. Gametes may be removed, placed in a hatchery, and subsequently returned to the donor system at the appropriate life history state (eyed egg, fry or fingerling). However, no more than one generation of separation from the donor system to stocking of the progeny will be allowed.
- D. Drainages should be established as wild stock sanctuaries on a regional and species basis. These sanctuaries will be areas in which no enhancement activity is permitted except gamete removal for broodstock development. Use of such reservoirs for broodstock development should be considered on a case-by-case basis, and sliding egg take removal schedules applied to such systems should be conservative.

- E. Fish releases at sites where no interaction with, or impact on significant or unique wild stocks will occur, and which are not for the purpose of developing, rehabilitation of, or enhancement of a stock (e.g., release for terminal harvest or in landlocked lakes) will not produce a detrimental genetic effect. Such releases need not be restricted by genetic concerns.

III. Maintenance of Genetic Variance

A. Genetic diversity among hatcheries

1. A single donor stock cannot be used to establish or contribute to more than three hatchery stocks.
2. Off-site releases for terminal harvest rather than development or enhancement of a stock need not be restricted by III.A.1, if such release sites are selected so that they do not impact significant wild stocks, wild stock sanctuaries, or other hatchery stocks.

B. Genetic diversity within hatcheries and from donor stocks

1. A minimum effective population (N_e) of 400 should be used for broodstock development and maintained in hatchery stocks. However, small population sizes may be unavoidable with chinook and steelhead.
2. To ensure all segments of the run have the opportunity to spawn, sliding egg take scales for donor stock transplants will not allocate more than 90% of any segment of the run for broodstock.

GUIDELINES AND JUSTIFICATIONS

I. Stock Transport

- A. Interstate: It is generally accepted that population of salmonids which have existed over many generations in a given watershed have evolved traits that make them best adapted for survival in that environment. The greater the distance that a population is transferred from its native environment or the greater the difference in environmental conditions between the donor and transplant stream, the less likely the genetic characteristics of the population will fit the new environment. If the fitness of the population is indeed reduced in the new environment, then the probability of the transplant succeeding would be affected. In addition, interbreeding of a transferred stock with indigenous stocks could transfer gene traits that would reduce the fitness of the native populations. In many states, discrete stocks cannot be identified because excessive movement and interbreeding have already occurred. The State of Alaska, therefore, desires to protect and develop local stocks by restricting the movement of live fish or eggs into the state. There are, however, several trans-boundary rivers penetrating British Columbia, Canada, that flow into the state of Alaska. In some instances, donors from these stocks might fit a well-designed management plan.
- B. Inter-regional: The environment can vary greatly from one region to another in a state as large as Alaska. For similar reasons given in I.A. above, the transfer of fish from one region to another is restricted. Consideration may be given to regional border areas, especially when no suitable donor stock is available within a region.

C. Regional: Although it is recognized that indigenous stocks are best for donor stock development, there have been numerous successful transplants, especially if the environment at the new site is similar to that of the donor stock and distance between the sites is not great. There is insufficient scientific data to predict how far or how diverse the environment must be before a negative impact will occur. However, it is believed that within a region site matching opportunities may be available. As site matching characteristics decrease and transplant distance increases within the regional borders greater justification is required for the proposed transplant. The following should be considered when selecting a donor stock:

1. Matching: Phenotypic characteristics of the donor stock should be matched to the environment at the site and to the management goals. Water chemistry and temperature profiles should be considered. Island stocks should be matched to other islands or to short rivers of comparable characteristics where possible. Time of spawning and fry emergence should be matched or compensated with the hatchery temperature required. Any deviations should be addressed and justified in the permit application or the annual management plan.
2. Migration Routes: The probable migration routes and potential user groups should be identified. The applicant must determine a probable migration route based on the migration route of the proposed stock and characteristics (topography) of the transplant site. Coded wire tagging of hatchery releases can determine the accuracy of migration route predictions as well as assess possible impact on local stocks.

II. Protection of Wild Stocks

A. Prevention of detrimental effects of gene flow from hatchery fish straying and interbreeding with wild fish.

Straying of hatchery fish released at the hatchery or off-station can potentially impact the fitness of wild fish populations through interbreeding of wild and hatchery fish. This assumes that hatchery and wild fish are adapted to different environments and either would presumably be less fit in the environment of the other and that hybrids would be less fit for either environment. Wild stocks have presumably been rigorously adapted to their native environment. Because of the large number of loci involved in the adaptation, many "successful" combinations of genetic information are possible along with the enormous number of "unsuccessful" combinations. Hybridization between discrete populations may produce a stock that has reduced fitness and therefore reduced production. Hatchery fish have been subjected to selection pressure for survival within artificial culture regimes, and may also have been originally derived from another stock adapted to totally different conditions than the impacted wild stock. Continued influx of hatchery fish together with the return of hybrids may alter the wild gene pool, reduce stock fitness, and thus threaten the survival of the wild population.

An alternative perspective is that hatchery strays will have little genetic impact on wild stocks. The influx of new genetic material through straying is a natural process in the development and expansion of salmon populations. If adaptation of the natural population is indeed very specific and selection is intense, then

selection will favor and maintain the genetic complex of the wild populations. If adaptation is less specific and less intensive, then the genetic impacts from gene flow are insignificant. It is true that some straying occurs among adjacent wild populations and in most cases has occurred for a long enough time that such populations are quite similar genetically. However, situations in which transplanted stocks are involved are not analogous, as transplanted stocks would be less similar and gene flow would have a more profound effect. It is also true that the impact of introgression into the wild gene pool of genes from fish transplanted from a radically different environment may be limited by natural selection. Again the situations of concern do not necessarily lie near this extreme; hybrids and strays may be fit enough to dilute or replace the wild genome. Inherent homeostatic mechanisms for gene expression may compensate for some genetic influx.

The magnitude of straying relative to the size of the wild run is the most important criterion, as massive spawning by hatchery strays may jeopardize a wild population by displacement on spawning habitat and superimposition of redds, as well as, genetic influx. A conservative management approach dictates avoiding release sites where large numbers of hatchery strays can be expected to interact with significant or unique wild stocks. This approach can be achieved by spatial or temporal isolation of the hatchery and wild stock.

B. Regional designation of significant and unique wild stocks.

The magnitude of salmon populations varies between watersheds from intermittent runs maintained by

straying to hundreds of thousands of fish. In evaluating the impacts of salmon enhancement projects, consideration must be given to the potential of detrimental effects from straying and intermingling with wild populations and possible resultant loss of wild production. Such consideration must take into account the benefits of the enhancement activity and the significance of the wild stocks impacted. Designation of criteria for runs of fish that are considered significant would greatly expedite the evaluation process. However, "significance" must be defined not only by the magnitude of the run, but also in the context of local importance and utilization. A small sockeye salmon stock near a village in southeast Alaska may be "significant", whereas the same size population may be too small to be considered a manageable entity in Bristol Bay. Because local utilization is an important concern, a regional planning group such as the Salmon Enhancement Regional Planning Teams, should consider what criteria will be used to determine significant stocks within a region and recommend such stock designations.

C. Stock rehabilitation and enhancement.

1. A watershed with significant wild stocks can only be stocked with progeny from the indigenous stocks. Rehabilitation of a watershed implies that there is insufficient production in habitat that formerly maintained a stock of some magnitude. Unless the indigenous stock has gone to extinction, use of an exogenous stock has potential for genetic damage noted in II.A. This damage will be exacerbated by the imprinting and homing of the transplanted stock to the impacted watershed, and potential displacement of wild

juveniles by the exotics stocked in the rearing habitat.

Enhancement of habitat not naturally accessible to salmon involves stocking eyed eggs, fry, or fingerlings, thus gaining production from this unutilized habitat. Where the inaccessible habitat is located above barriers on watersheds that maintain significant natural populations, stocking nonindigenous populations again has potential for genetic impacts noted in II.A., exacerbated by imprinting and homing of the transplanted stock to the watershed. For both rehabilitation and above barrier stockings, use of the indigenous stock alleviates these concerns.

2. When enhancing a stream using the indigenous stock, the fish used for stocking shall not be removed from the wild system to a hatchery for more than one generation.

Hatchery incubation and rearing select for a limited set of biological and behavioral traits which are not necessarily the most suitable for survival in the wild environment. Because of this potential for such selection, the transfer of hatchery fish to rehabilitate or enhance stocks in depleted or underutilized watersheds runs the risk of altering the genetic character of the wild stock, even if the indigenous stock was the original donor stock for hatchery population. By restricting the separation between the transfer to the hatchery and the stocking to no more than one generation (e.g., eggs taken in a given year are cultured to fry or fingerling release at the hatchery; eggs or fish from the returns to the

hatchery of this donor transplant are used for stocking), the risk of negative effects due to selection in the hatchery are minimized.

D. Establishment of wild stock sanctuaries.

As noted in preceding sections, there is concern that hatchery culture of salmon through their freshwater (and in some cases, initial estuarine) life history phases may select for a limited set of biological traits that are not suitable for wild populations. Loss of genetic variability through intensive inbreeding for domestication and desired traits has often resulted in detrimental genetic effects in agronomy and agriculture, such as reduced resistance to disease or adverse environmental conditions. Original wild strains can provide the genetic variability needed to outbreed domestics and alleviate inbreeding depression. Because there is potential for detrimental impacts due to reduction of genetic variability, there is a need to preserve a variety of wild types for future broodstock development and outbreeding for enhancement programs. Designation of watersheds where hatcheries or hatchery plants are not allowed would allow wild stocks within these watersheds to be subjected to natural selection only, within the life history phases cultured at hatcheries. These watersheds would be "gene banks" of wild-type genetic variability.

III. Maintenance of Genetic Variance

A. Genetic diversity among hatcheries.

There is general agreement that by introducing and maintaining a wide diversity of wild donor stock

populations into the hatchery system that the prospects for long term success of the hatchery program in Alaska will be enhanced. Diversity tends to buffer biological systems against disaster, either natural or man-made. Developing and maintaining hatchery broodstock from a wide variety of donors will buffer the hatchery system against future catastrophes. Agricultural crop production in the U. S. provides a prime example of the dangers of genetic uniformity.

In an effort to increase yield, plant breeders have come to rely on a few highly productive strains. In 1970 approximately 15% of the corn production in the United States was lost to corn blight. The corn blight responsible, a mutant of the normal blight causing fungus, did not attack all strains. Only one strain of corn was vulnerable, but that strain of corn was grown by nearly every farmer in the country. Breeders were able to recover from the corn blight epidemic by replacing Texas cytoplasm with normal cytoplasm. Recovery was rapid because adequate genetic variability was available. There are other examples.

How does this relate to salmonid culture? Salmonid stocks apparently differ in levels of disease resistance, temperature tolerance, acid tolerance, and in their response to artificial selection. It seems imprudent to assume that conditions similar to those found in agriculture will not occur in aquaculture. In addition, the ability to genetically improve hatchery broodstock performance in the future will depend on the availability of genetic variability such as is found among wild salmonid stocks. A hatchery system with a variety of diverse broodstocks will be a valuable resource.

Genetic diversity does not guarantee protection from disaster, but uniformity seems to invite catastrophe. Local failures are inevitable within the hatchery system. It seems prudent to provide the system with a level of insurance by developing and preserving diversity among hatcheries.

Off-site releases for terminal harvest, whether for the commercial fishery or for a put and take sport fishery should have no adverse genetic effect if they are released at sites selected so that they do not impact significant wild stocks, wild stock sanctuaries or other hatchery stocks. The success of this type of release from a genetic standpoint depends on the ability to manage and harvest the return. If returns can not be harvested, increased straying may result which might lead to an impact on wild stocks at a greater than expected distance from the release site.

B. Genetic diversity within hatcheries and from donor stocks.

There is a general consensus among geneticists that fitness (reproductive potential) is enhanced by heterozygosity (genetic variability). Any loss of genetic variation will be accompanied by a concomitant reduction in fitness. Genetic variation allows a population to adapt to a changing environment or to adapt to and colonize a new environment. Available genetic variation determines how rapidly a population will respond to either artificial or natural selection. On the other hand, selection, inbreeding and random genetic drift will reduce genetic variability in a population.

Natural selection, that is selection for fitness, is a continuing process and should not be so intense that it

has a significant effect in reduction of genetic variation, unless the population is in a new and quite different environment. Artificial selection on the other hand can be very intense, but can either be avoided or designed to assure that possible negative effects to fitness are offset by increased production efficiency due to the selection program, and by more efficient culture techniques. Inbreeding due to the deliberate mating of related individuals can be easily avoided in salmon hatcheries. Undoubtedly, in hatcheries and possibly in natural stocks the most important cause of loss of genetic variation is random genetic drift. In hatcheries reduction of genetic variation caused by inbreeding and genetic drift can easily be avoided by using adequate numbers of spawners.

Random genetic drift in general refers to fluctuations in gene frequency that occur as a result of chance. Such fluctuations occur, especially in small populations, as a result of random sampling among gametes. The amount of change but not the direction of change, can be predicted. The rate of this change is related inversely to effective population size (N_e). The smaller the effective population size the greater the fluctuation in gene frequencies. In small populations random genetic drift can result in inadvertent loss of genetic variability which may significantly reduce the fitness of the population.

Effective population size (N_e) is defined as the size of an idealized population that would lose genetic variability at the same rate as the sample population. An idealized population is one in which there is no

mutation or selection, there are equal numbers of males and females, mating is random, etc. Obviously it is very unlikely that any natural population will meet all criteria for an idealized population.

Breeding structure of a population can profoundly affect the rate at which genetic variability is lost. However, we can determine the effective breeding size (N_e) for breeding structures and obtain the rate of inbreeding (ΔF) as

$$\Delta F = 1/2N_e$$

so the consequences of breeding structure can be related to the loss of variation.

Many breeding structure variations can influence the effective population size. Four seem likely to operate in a salmon hatchery population: (1) numbers of males and females in the breeding population; (2) unequal numbers in successive generations; (3) nonrandom distribution of offspring among families; and (4) overlapping generations. These are discussed in greater detail in Appendix A.

Any of these variations in breeding structure may have a marked effect on N_e . Although it may be impossible to control or even to measure variation in family size it is important to keep in mind the relationship to effective population size. Breeding plans that would aggravate or increase the variation of family size should be avoided. The effect of overlapping populations is to increase the effective population number, in that individuals mating in different years contribute to greater diversity. For example, it would

take a larger number of pink salmon each year to maintain $N_e = 400$ than it would sockeye salmon.

The factor having the greatest potential effect in the hatchery and over which we have most control is sex ratio. As the formula indicates (Appendix A) the effective population size is affected most by the numbers of the least frequent sex. It is important to consider this in the breeding plan. In salmon, because a male can be used to fertilize the eggs of a large number of females, there is a temptation to do so. This temptation should be moderated by the necessity to maintain an effective population size which will assure that adequate genetic variation is maintained in the population. A minimum effective population (N_e) of 400 should be maintained. At this size the rate of inbreeding will be 0.125 percent per generation which should not have a significant effect on the long term fitness of the population.

In some cases, for example with chinook and steelhead, small population size may be unavoidable. In such cases a plan should be developed to offset the effects of small population size by infusion of genes from a source outside the hatchery population, such as the original donor source. Help in designing these breeding plans can be obtained from the Principal Geneticist, FRED Division, Alaska Department of Fish and Game.

While developing hatchery stocks from wild donor sources it is important that the genetic variability in the donor stock be protected. Cropping of the early or late run segments of a donor stock can change the timing of that run, which will reduce genetic variability of the population and may be detrimental to the stock's prospects for long term survival. To prevent

such selection, sliding egg take scales for donor stock transplants should allocate no more than 90% of any segment of a run for broodstock.

RESEARCH

The necessity for much of this policy arises from our ignorance of the genetics of wild salmon populations and the effects of their domestication in hatcheries. The policy is based more on extrapolation from other disciplines such as agriculture than on first-hand knowledge of our resource. As a result, the policy is a somewhat conservative interpretation of these data in order to assure the long-term viability of salmon populations. The Committee has identified several areas in which specific knowledge would clarify this policy and contribute to the effectiveness of salmon enhancement. The Committee encourages cooperative research efforts among the university, state, federal and private sectors directed toward the general areas listed below.

1. Development of performance profiles of hatchery stocks and potential for genetic improvement. Information about stocks kept in culture will be useful in several ways. If taken in a standard manner, the data will be useful in determining the extent of variability in the species and will aid in the choice of stock to be used for outplanting or transplanting. The information will also be helpful in maximizing the production of a particular facility.
2. Potential for genetic improvement of cultured stocks. A sequel to the cataloging of the variability within and among stocks will be to experimentally assess the potential for genetic improvement by selective breeding. To do this, it is necessary to determine the heritabilities for traits of interest, that is the part of the phenotypic variability present in a population which results from genetic (heritable) causes as opposed to environmental causes. Traits such as size of adults, age of return and various timing parameters are particularly interesting to industry.

Application of artificial selection is responsible for the enormous advances that have been made in agriculture; the potential also exists in aquaculture.

3. Assessment of the effect of introgression of genes from hatchery fish into wild populations. To examine this effect, one must first have an estimate of the rate of straying and the factors that influence straying. Such factors might include transplant distance, run strength, source of the hatchery stock and year-to-year environmental differences. By using a genetically marked stock, one can monitor the flow of "hatchery genes" into other populations. Because the effect of such introgression may develop over time, it is necessary that such an experiment be conducted over several generations. For this kind of study, it may be necessary to develop a means for marking fish cultured at production levels.

The second part of this problem is to establish the impact of introgression. A range of potential interactions is possible ranging from introgression between two unrelated stocks to the introgression of fish subject to the selective pressures of hatchery back into the wild stock from which they were derived. Research to examine these effects could best be done in an experimental hatchery where hybrid stocks could be produced and all releases marked. Post sampling and stream walking would be necessary to evaluate survival, straying and other phenotypic effects.

4. The effects of inbreeding and maintenance of inbred lines. Accompanying the artificial propagation of a species is the potential for inbreeding, loss of genetic variability and increased homozygosity. Information pertinent to the extent of inbreeding depression that results from various levels of inbreeding is necessary in determining adequate effective population sizes. This is especially important for species

for which a large effective population size is difficult to maintain. In addition, this information would permit a judgement on the efficacy of enhancing very small remnant populations. This work could be done both by performing crosses designed to accomplish some level of inbreeding, and by the maintenance of small randomly breeding populations. In both cases, it is important to keep careful controls.

APPENDIX A

Appendix A

The relationship of breeding structure, effective population size, and rate of inbreeding.

Breeding structure can profoundly affect effective breeding size (N_e) of a population. We can, at least in theory, determine the effective breeding size for many breeding structures and obtain the rate of inbreeding (ΔF) as

$$\Delta F = 1/2N_e$$

relating variation in breeding structure to loss of variation.^{1/}

The following demonstrates the consequence of some breeding structures to effective population size.

Number of males and females: Unequal numbers of males and females in the breeding population reduce effective population size. Sex ratio is related to effective population number (N_e) as

$$N_e = 4N_m N_f / (N_m + N_f)$$

where N_m and N_f refer to the total number of males and females respectively. The effective population size is strongly influenced by the number of the least frequent sex.

Unequal numbers in successive generations: If the numbers of breeding individuals is not constant in successive generations the mean effective number is the harmonic mean of the number in

^{1/} See D.S. Falconer. 1981. Introduction to Quantitative Genetics. Longman Inc., New York.

each generation. Over generations the effective number is approximately,

$$1/N_e = 1/t(1/N_1 + 1/N_2 + 1/N_3 + \dots + 1/N_t).$$

The generation that has the smallest number will have the largest effect.

Nonrandom distribution of offspring among families: When there is large variation in family size the next generation is made up of the progeny of a smaller than expected number of parents. This can be related to loss of genetic variation through effective population number as

$$N_e = 4N/(V_k + 2)$$

where V_k refers to the variance in family size. When variation of family size V_k is equal to 2, then $N_e = N$. When the number of males and females are unequal, the variance of family size may be unequal in the two sexes and

$$N_e = 8N/(V_{km} + V_{kf} + 4)$$

where V_{km} and V_{kf} are the variance of family size for males and females respectively.

Overlapping generations: In species other than pink salmon generations are not discrete, they are overlapping. When generations overlap the effective population size is

$$N_e = 4N_c L/(V_{km} + 2)$$

where L is the generation time and N_c is the number of individuals born in a year, that is the cohort size. The cohort size N_c is related to the total number (N_t) by $N_c = N_t/E$ and E is the mean age at death. As before V_{km} is the variation of family size.

The effect of unequal sex ratio and unequal numbers in successive generations on population size can be easily estimated. On the other hand it will be difficult or perhaps impossible to estimate the variance of family size. Nevertheless, we should keep in mind the relationships of family size and overlapping generations. Overlapping generations will in general increase the effective population number in that individuals mating in different years contribute to greater diversity. Variance of family size can radically reduce effective population size. Procedures that contribute to variance of family size or separation of year classes should be avoided.

The best thing that's happened to the South since cotton?

A fish tale worth telling

■ "Farm-raised catfish is as mild and fresh tasting as any fish you could ever eat," it says on the box of Mrs. Paul's frozen catfish fillets. Catfish? Yep, but it takes three more puffed-up paragraphs to explain that this is not the ugly, whiskered 10-pound tough guy that dredges the bottom of the Mississippi River for sustenance. No sir. This, says Mrs. Paul's, is an "exquisite" fish.

It's going to take more than three paragraphs for the Richards Group, the new advertising agency for the catfish industry, to convince consumers of that. But last month, for the first time, the nation's catfish farmers anted up \$1.5 million for the Dallas-based firm to try. And just in case anybody thought they didn't mean business, last week they brought in Golin Harris, the public-relations firm for companies such as McDonald's and Sara Lee.

"We're tired of this," says Bill Allen, head of the American Catfish Institute, the \$200 million industry's marketing arm in Belzoni, Miss. "We are trying to differentiate our product from the scavenger fish that everybody thinks about."

Farm-raised catfish is, in fact, a different product. Grown in man-made spring-water ponds, the fish is fed a rich diet of grain and minerals. Enjoyed for years by Southerners, who eat it fried with cornmeal fritters called hush puppies, it has shown up lately on menus in trendy Manhattan restaurants responding to the regional-food craze. Last year, Church's, the nation's second-largest fried-chicken chain, bought \$55 million worth of fillets to introduce at their outlets nationwide. But that is not enough. Says Allen: "We want it to be perceived as a classic, Dover-sole kind of fish."

Swimming upstream

Unfortunately, says Richards Group account executive Jeff Upshaw, "there is more than one misconception about catfish." Market research shows that in addition to its reputation as a mud grubber, catfish is believed by some consumers to be good only when fried, while others don't want to prepare it at home because they think it smells bad. Harder to combat is its image as what Upshaw calls a "strictly jeans-and-T-



Diners find the fish produced by Paul Battle's ponds more appealing on a plate

shirt product. People feel it's not chic to order it in an upscale restaurant."

This is a problem that catfish processors have already begun to fight at the food-service level. Delta Catfish Processors, Inc., of Indianola, Miss., the world's largest catfish processor, recently hired New Orleans chef John Folse as a consultant. His demonstrations of elegant recipes such as catfish mousse and pan-sautéed catfish with sauce meunier are available on video.

In New York, chic delicatessens such as Balducci's and Zabars carry a smoked version of the fish, and fried catfish is featured on menus from the Gulf Coast restaurant in Greenwich Village to Park Avenue's Ritz Cafe. Delta Catfish Processors' Delta Pride line now

offers preseasoned frozen Catfish Classics to restaurants lacking adventurous chefs. Available in Cajun, butter-garlic and lemon-pepper flavors, they will soon be available in grocery stores.

All this is good news to the ailing farmers of the Mississippi Delta, where 85 percent of the world's catfish is produced. John Dillard, a catfish farmer and stockholder in Delta Catfish Processors, says that this year Mississippi farmers will produce 250 million pounds of catfish—30 million pounds more than last year—and farmers in Arkansas, Alabama and Louisiana will add to the pile. "If we end up with 20 million pounds we can't sell, we're in trouble. We've got to sell them because there's no loan on catfish, no government payments."

Like most catfish farmers, Dillard began growing catfish on unused farmland as a sideline to his main business of cotton, soybean and rice farming. But now, he says, "the catfish business is bigger than our farming operation in terms of dollars." Says Webb Franklin, Mississippi's second-district congressman: "Catfish farming is the only bright spot agriculturally I see in my district."

There even are rumblings of changing the generic name from farm-raised catfish to Mississippi-raised or Delta-raised, a possibility the Richards Group intends to explore. Why not? Idaho has its potatoes and Florida its oranges. Maybe it's time for Mississippi to claim catfish.

CRISP FRIED CATFISH

- 6 small farm-raised catfish fillets
- 1 teaspoon salt
- 1/4 teaspoon pepper
- 2 cups yellow cornmeal in a brown paper bag
- 1 quart cooking oil

Sprinkle catfish lightly with salt and pepper. When ready to fry, drop fish into the bag and shake to coat with cornmeal.

Use a deep pot or iron skillet filled half full with cooking oil. Heat until just smoking hot. Place each piece of fish into oil separately. Cook on high heat until fish floats to the top and reaches a golden brown. Drain well on paper towels. Serve hot. Makes 6 servings.



by Julia Reed

MEMORANDUM

State of Alaska

Department of Law

TO: Hon. Don Collinsworth
Commissioner
Dept. of Fish and Game

DATE: October 25, 1988
FILE NO: 221-88-0958
TEL. NO: 465-3600
SUBJECT: DeNardo v. State

FROM: ^{LIS}
Larri Irene Spengler
Assistant Attorney General
Natural Resources Section
Department of Law

CONFIDENTIAL: ATTORNEY/CLIENT PRIVILEGE

In June of this year, the state was served with the complaint filed in superior court in Anchorage by Daniel DeNardo, representing himself, in which Mr. DeNardo requests the court to issue a judgment declaring that the legislature's extension of the moratorium on most finfish farming (ch. 145, SLA 1988) is unconstitutional, in violation of the interstate commerce clause, the privileges and immunities clause, and federal equal protection guarantees. DeNardo v. State, 3AN 88-6467 Civil. Mr. DeNardo also requests in the complaint an injunction precluding enforcement of the "acts of the legislature forbidding issuance of the necessary licenses for salmon farming."

As explained in the July 5, 1988, memorandum from Liza McCracken, Assistant Attorney General in the Anchorage Attorney General's Office, Mr. DeNardo is a fairly well-known pro se litigant, who has filed a number of actions against various state officials and challenged several statutory provisions. Before going on an extended leave, Liza filed a motion to dismiss the action based on lack of standing, which motion was denied by superior court Judge Rene J. Gonzalez, on October 7, 1988.

Subsequently, on October 11, 1988, Mr. DeNardo filed a motion for summary judgment, arguing mainly that the moratorium is a violation of the United States Constitution's commerce clause, as being protectionist in nature. I will be opposing that motion for summary judgment, and will in turn file a cross-motion for summary judgment on all three claims. I will keep you informed of any developments.

CONFIDENTIAL: ATTORNEY/CLIENT PRIVILEGE

Hon. Don Collinsworth
Commissioner, ADF&G
Our file 221-88-0958

October 25, 1988
Page 2

LIS:dlm

cc: Hon. Dick Eliason
P.O. Box 143
Sitka, AK 99835

Norman Cohen
Dave Benton
Brian Allee
Department of Fish & Game

Steve White
Juneau AGO

Liza McCracken
217 Hambletonian
Eugene, OR 97401

IN THE SUPERIOR COURT FOR THE STATE OF ALASKA
THIRD JUDICIAL DISTRICT AT ANCHORAGE

DANIEL DENARDO,)
)
Plaintiff,)
)
vs.)
)
STATE OF ALASKA,) 3AN 88-6467 Civil
)
Defendant.)

SUBSTITUTION OF COUNSEL

PLEASE TAKE NOTICE that Larri Irene Spengler, Assistant Attorney General, Department of Law, P.O. Box K, State Capitol, Juneau, Alaska, 99811, phone: (907) 465-3600, hereby enters her substitution for Sarah Elizabeth McCracken as counsel of record in the above-captioned matter on behalf of defendant State of Alaska.

Copies of all notices, motions and pleadings should be sent to the address referenced.

DATED: *October 26, 1988*

GRACE BERG SCHAIBLE
ATTORNEY GENERAL

By: *Larri Irene Spengler*
Larri Irene Spengler
Assistant Attorney General

This is to certify that on this date a copy of the foregoing is being caused to be mailed to plaintiff at the following address:

P.O. Box 100632
Anchorage, AK 99510

Dorian L. Morris 10-26-88
Dorian L. Morris Date

IN THE SUPERIOR COURT FOR THE STATE OF ALASKA
THIRD JUDICIAL DISTRICT AT ANCHORAGE

DANIEL DENARDO,)
)
Plaintiff,)
)
vs.)
)
STATE OF ALASKA,) 3AN 88-6467 Civil
)
Defendant.)
)

MOTION FOR SUMMARY JUDGMENT

The state requests that summary judgment be entered on its behalf in this case. This motion is supported by the accompanying memorandum, and by attachments 1 and 2 submitted with the state's July 13, 1988, motion to dismiss.

DATED: *October 26, 1988*

GRACE BERG SCHAIBLE
ATTORNEY GENERAL

By: *Larri Irene Spengler*
Larri Irene Spengler
Assistant Attorney General

This is to certify that on this date a copy of the foregoing is being caused to be mailed to plaintiff at the following address:

P.O. Box 100682
Anchorage, AK 99510

Dorian L. Morris 10-26-88
Dorian L. Morris Date

IN THE SUPERIOR COURT FOR THE STATE OF ALASKA
THIRD JUDICIAL DISTRICT AT ANCHORAGE

DANIEL DENARDO,)
Plaintiff,)
vs.)
STATE OF ALASKA,) 3AN 88-6467 Civil
Defendant.)

MEMORANDUM IN OPPOSITION TO PLAINTIFF'S
OCTOBER 11 MOTION FOR SUMMARY JUDGMENT & IN
SUPPORT OF STATE'S MOTION FOR SUMMARY JUDGMENT

I. INTRODUCTION

This case involves a constitutional challenge to a legislatively mandated moratorium on issuance of permits or licenses for salmon farming. The complaint seeks a declaratory judgment which would invalidate a legislative moratorium on authorization of most commercial finfish farming until July 1, 1990. Chapter 70, SLA 1987, extended by sec. 21, ch. 145, SLA 1988.

The complaint alleges that the legislature's action violates three provisions of the United States Constitution: article I, section 8, clause 3 (interstate commerce); article IV, section 2 (privileges and immunities); and the Fourteenth Amendment (equal protection).

On October 11, 1988, plaintiff moved for summary judgment with respect to the interstate commerce and equal

1 protection claims. The state herein opposes that motion, and
2 supports its cross-motion for summary judgment on all three
3 claims of the complaint. Summary judgment is appropriate under
4 Alaska Civil Rule 56 if there is "no genuine issue as to any
5 material fact and the moving party is entitled to judgment as a
6 matter of law." As will be shown below, the relevant facts are
7 undisputed, and the state is entitled to judgment on the inter-
8 state commerce, privileges and immunities, and equal protection
9 claims.

10 II. BACKGROUND

11 The subject of fish farming has been of increasing
12 public interest in Alaska in recent years as reflected by the
13 legislature's actions in 1987 and 1988. Chapter 70, SLA 1987;
14 ch. 145, SLA 1988. As noted in a column by Senator Dick
15 Eliason, chief sponsor of the 1988 legislation which clarified
16 the authorization for shellfish farms while continuing the mor-
17 atorium on most finfish farms, "fishermen, environmental organ-
18 izations, recreational and other user groups, as well as a great
19 number of individual citizens" addressed the legislature during
20 an extensive series of public hearings in coastal communities
21 throughout the state. Attachment 1 to state's motion to dis-
22 miss. "To the question of whether Alaska should allow develop-
23 ment of salmon farms to begin this year, the response has been a
24 resounding 'no!'" Id.

25 Questions in recent years regarding whether commercial
26 finfish farming was or could be authorized in Alaska led to

1 several attorney general memoranda of advice. These concluded
2 that: (1) finfish farming is not prohibited by the Alaska or
3 United States Constitutions or by statute (other than the
4 present moratorium); (2) the activity may only occur if allowed
5 by regulations; and (3) finfish farming is not presently author-
6 ized by regulation of the Board of Fisheries, quite apart from
7 the present legislative moratorium prohibiting such authoriza-
8 tion. See 1985 Inf. Op. Att'y Gen. (Jan. 31; 663-84-0187); 1987
9 Inf. Op. Att'y Gen. (Mar. 10; 661-87-0360); 1987 Inf. Op. Att'y
10 Gen. (July 8; 663-87-0454); 1988 Inf. Op. Att'y Gen. (June 24;
11 663-88-0500).

12 There are presently no commercial finfish farming
13 operations in Alaska, nor have there been any in the past.
14 Attachment 1 to state's motion to dismiss (Eliason column).
15 However, even under the moratorium challenged in this case, the
16 activity could be authorized by regulation in a privately owned
17 fresh water body that has no outlet to state waters. Section
18 1(b), ch. 70, SLA 1987; see 1988 H. Jour. pp. 3716, 3733; 1988
19 S. Jour. p. 3614; see also 1988 Inf. Op. Att'y Gen. (June 7;
20 883-88-0143). Commercial shellfish farming has been authorized
21 previously, and is now specifically governed by the provisions
22 of the 1988 legislation, codified at AS 16.40.100 -- 16.40.199,
23 and by 5 AAC 41.001 and 5 AAC 41.200 -- 5 AAC 41.400. See also
24 1988 Inf. Op. Att'y Gen. (June 7; 883-88-0143; 1988 Inf. Op.
25 Att'y Gen. (June 24; 663-88-0500).

1 Fish farming is defined in AS 16.05.940(14) as "the
2 business of propagating, breeding, raising, or producing fish
3 . . . in captivity for the purpose of marketing the fish . . .
4 or their products." That provision also defines "captivity" as
5 having the fish "under positive control, as in a pen, pond, or
6 an area of land or water which is completely enclosed by a gen-
7 erally escape-proof barrier." Thus, fish farming is distin-
8 guished from the raising of fish in hatcheries, where fish are
9 released into the wild to grow to maturity; private nonprofit
10 salmon hatcheries have been authorized in Alaska since 1974
11 under AS 16.10.375 -- 16.10.480.

12 There are many public policy considerations involved
13 in the issue of mariculture generally, and commercial salmon
14 farming specifically. Concerns include the economic effect on
15 existing commercial fisheries, the allocation of public resour-
16 ces, the economic effect on local communities, the health of
17 fish and other species, and impact on availability of recrea-
18 tional areas. See attachment 1 to state's motion to dismiss
19 (Eliason column). In addition, potential environmental impacts
20 of salmon farming are clearly areas of concern, including "water
21 circulation and suspended sedimentation," "organic sedimentation
22 and impacts on benthic organisms," "fish and megafauna impacts,"
23 "water quality impacts," "increased phytoplankton growth," "in-
24 troduction of non-native species," "use of antibiotics and hor-
25 mones," "proliferation of human pathogens," "transmission of
26 disease to wild fish," "genetic alteration," "use of toxic

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1 substances," "conflicts with marine birds and mammals," and "im-
2 pacts from associated hatchery and processing operations." 45
3 Anadromous Law Fish Memo, "Anticipating the 'Blue Revolution':
4 The Growth of the Salmon Farming Industry and its Public Policy
5 Implications" (April 1988), pp. 6-11; attachment 2 to state's
6 motion to dismiss.

7 Awareness of such important policy issues led the leg-
8 islature to establish a finfish farming task force in the 1988
9 legislation which extended the finfish farming moratorium until
10 1990. Section 20, ch. 145, SLA 1988. The task force is to
11 examine a number of questions, including whether "the farming of
12 finfish can be conducted in a manner that protects the health of
13 the state's fishery resources," what criteria should be used for
14 "the siting of finfish farms to minimize the land use conflicts
15 and protect the environment," and the "net economic costs and
16 benefits of finfish farming in the state to state residents,"
17 including an examination of jobs created or lost, tax revenue,
18 and cost of state regulation and monitoring. Id. In addition,
19 the task force is to consider the "cost of providing adequate
20 regulation of finfish farming to protect wild stocks, the envi-
21 ronment, public health, and existing beneficial uses of the
22 state's coastal water and land" and the "role of the private
23 sector in providing pathological and other services." Id.

24 It is against this background of legislative concern
25 that plaintiff's claims must be evaluated.
26

1 III. ARGUMENT

2 A. The Moratorium Does Not Violate the Commerce Clause

3 Plaintiff argues that the challenged regulation vio-
4 lates article I, section 8, clause 3, of the United States Con-
5 stitution, which provides:

6 Congress shall have power . . . to regulate com-
7 merce within foreign nations, and among the sev-
8 eral states, and with Indian tribes.

8 The test for the commerce clause analysis was discussed by the
9 United States Supreme Court in Hughes v. Oklahoma, 441 U.S. 322,
10 336 (1979). The court said that under the commerce clause it
11 must inquire

12 (1) whether the challenged statute regu-
13 lates evenhandedly with 'incidental' effects on
14 interstate commerce, or discriminates against
interstate commerce either on its face or in
practical effect;

15 (2) whether the statute serves a legitimate
16 local purpose; and if so,

17 (3) whether alternative means could promote
18 this local purpose as well without discriminating
against interstate commerce.

19 The moratorium challenged here applies evenhandedly to
20 both Alaska residents and nonresidents, with only "incidental
21 effects" on interstate commerce. Under the moratorium, nonstate
22 residents are in the same position as all Alaska residents --
23 they may engage in commercial shellfish farms under the statutes
24 and under the applicable regulations, they may request the Board
25 of Fisheries to authorize finfish farming in any "privately
26

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1 owned fresh water body that has no outlet to state water," */
2 and they may not engage in other commercial finfish farming. In
3 addition, nonstate residents and residents who are not interest-
4 ed in finfish farming may fall into any one of a number of cate-
5 gories -- outdoor recreationalists concerned with the continued
6 availability of prime coastal sites for recreation, commercial
7 fishermen concerned with competition on the economic front,
8 environmentalists concerned with maintaining the quality of
9 Alaska's marine environment and the health of Alaska's native
10 stocks. It is clear that there is no discrimination against
11 interstate commerce either on the face of the moratorium chal-
12 lenged here, or in its practical effect. Thus, the commerce
13 clause analysis need not be pursued further.

14 To the extent, however, that it is relevant, the
15 requirement of a legitimate local purpose has been clearly dem-
16 onstrated in the list of genuine concerns about land use, envi-
17 ronmental quality, and allocation of available resources, dis-
18 cussed above. The legitimate local purpose -- allowing time to
19 study these important issues before embarking on a program
20 authorizing finfish farming in Alaska -- could not be promoted
21 by any alternative means, since allowing any finfish farming
22 other than in private ponds not connected to state water could
23
24

25 */ Section 1(b), ch. 70, SLA 1987.
26

1 begin to have the deleterious effects which are the concern of
2 the legislature, and are the job of the task force to examine.

3 Aside from the conclusion that the commerce clause is
4 not violated because the challenged moratorium regulates even-
5 handedly, it is clear that plaintiff has no standing to chal-
6 lenge the moratorium on this ground. According to section II,
7 paragraph 1, of the complaint, plaintiff is "a citizen of
8 Alaska," and thus even if the moratorium discriminated against
9 interstate commerce (which it doe not), he would not be injured
10 by that discrimination, and would have no standing to challenge
11 it on that basis. Moore v. State, 553 P.2d 8 (Alaska 1976).

12 Therefore, the state's motion for summary judgment on
13 the commerce clause issue should be granted.

14 B. The Moratorium Does Not Violate Privileges and Immuni-
15 ties Principles

16 Plaintiff argues in his complaint that the challenged
17 regulation violates article IV, section 2, of the United States
18 Constitution, which provides:

19 The citizens of each state shall be entitled
20 to all the privileges and immunities of the citi-
21 zens of the several states.

22 In analyzing this issue, the court will have to apply the frame-
23 work developed by the judicial system for the analysis of
24 privileges and immunities claims. In Robison v. Francis, 713
25 P.2d 259, 263 (Alaska 1986), the Alaska Supreme Court noted that
26 the clause does not protect nonstate residents against "all
forms of discrimination." Its reach is limited to "fundamental

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1 rights" involving "basic and essential activities, interference
2 with which would frustrate the purpose of the formation of the
3 union." Id. quoting Baldwin v. Montana Fish and Game Commis-
4 sion, 436 U.S. 371, 387 (1978).

5 Even if a right is involved which triggers the privil-
6 eges and immunities analysis, the clause "is not an absolute."
7 Toomer v. Witsell, 334 U.S. 385, 396 (1948). While it does pro-
8 hibit discrimination against residents of other states "where
9 there is no substantial reason for the discrimination beyond the
10 mere fact that they are citizens of other states," it does not
11 preclude "disparity of treatment in the many situations where
12 there are perfectly valid independent reasons for it." Id. The
13 court explained that "the inquiry in each case must be concerned
14 with whether such reasons do exist and whether the degree of
15 discrimination bears a close relation to them." Id. The court
16 cautioned that the

17 inquiry must also, of course, be conducted with
18 due regard for the principle that the states
19 should have considerable leeway in analyzing
20 local evils and in prescribing appropriate cures.

21 Id.

22 As discussed with respect to the commerce clause
23 issues above, the challenged moratorium simply does not impact
24 nonstate residents any differently than it impacts state resi-
25 dents, and thus the privileges and immunities test is not even
26 triggered. Even if there were some impact on nonstate residents
which was different from that on state residents, there are, as

1 discussed above, a number of "perfectly valid independent rea-
2 sons" for the moratorium, which gives the legislature a chance
3 to study the important policy questions raised by finfish farm-
4 ing, including environmental and land use impacts.

5 Again, just as with respect to the commerce clause
6 argument above, plaintiff lacks standing to bring this chal-
7 lenge. Plaintiff is an Alaska resident, and thus even if this
8 moratorium had a disproportionate impact on nonstate residents
9 (which it does not), he would have no standing to make this
10 challenge. Moore v. State, 553 P.2d 8, 23 (Alaska 1976).

11 Thus, the state's motion for summary judgment on the
12 privileges and immunities issue should be granted.

13 C. The Moratorium Does Not Violate Equal Protection Prin-
14 ciples

15 Plaintiff argues in his complaint that the challenged
16 moratorium violates the equal protection provisions of the Four-
17 teenth Amendment of the United States Constitution, which pro-
18 vides that no state may

19 deny to any person within its jurisdiction the
20 equal protection of the laws.

21 The United States Supreme Court has applied dual standards to
22 equal protection challenges. The state must prove a "compelling
23 state interest" to justify classifications based on race, na-
24 tional origin, or alienage, and such classifications are subject
25 to strict scrutiny. Commercial Fisheries Entry Commission v.
26 Apokedak, 606 P.2d 1255, 1261 (Alaska 1980). A similar standard
is applied when fundamental rights are at stake. Id.

1 In cases not involving suspect classes or fundamental
2 rights, the United States Supreme Court has generally applied a
3 less restrictive rational basis test. Id. at 1262. Plaintiff
4 here does not suggest that the alleged legislative moratorium on
5 finfish farming involves a suspect classification, and "the
6 availability of employment opportunity has not been considered a
7 fundamental right so as to require application of the compelling
8 state interest state." Id. The applicable test, therefore is
9 "whether the classification is reasonable, possesses some
10 rational connection to the measure's legitimate purpose and
11 treats all within the class alike." Id.

12 The legislative moratorium on finfish farming, other
13 than in privately owned ponds without an outlet to state waters,
14 establishes no classifications in itself. In other words, it
15 does not say that certain individuals may participate in finfish
16 farming in state waters, and others may not. Thus, there is no
17 classification inherent in the moratorium which the state need
18 defend against an equal protection challenge.

19 It may be that plaintiff is arguing that individuals
20 desiring to develop finfish farms are somehow similarly situated
21 to individuals engaged in commercial salmon fishing in Alaska,
22 or to individuals involved in operating private nonprofit salmon
23 hatcheries. That is simply not the case.

24 As mentioned in section II above, finfish farming is
25 an untested type of development in Alaska, which raises a number
26 of environmental, land use, allocation, and economic concerns.

ATTORNEY GENERAL, STATE OF ALASKA
STATE CAPITOL
P.O. BOX K, JUNEAU, ALASKA 99811
PHONE 465-3600

1 In contrast, commercial fishing -- as well as sport fishing and
2 subsistence fishing -- has been authorized and conducted in
3 Alaskan waters since long before statehood. The impacts and
4 risks of commercial fishing are relatively well-known, and it
5 does not pose any danger to native stocks, other than through
6 the possibility of overharvest, which is controlled by the
7 state's conservation laws. Similarly, private nonprofit salmon
8 hatcheries have been authorized since 1974, under strict statu-
9 tory standards governing siting, salmon egg sources, inspec-
10 tions, release sites, reporting requirements, etc. AS 16.10.375
11 -- 16.10.470. In addition, hatcheries are subject to numerous
12 and detailed regulations. 5 AAC 40.005 -- 5 AAC 40.990. Fur-
13 ther, hatcheries dovetail well with existing economic dependence
14 of coastal areas on commercial fishing, since the hatchery fish
15 are available for harvest by commercial fishermen, as well as
16 sport and subsistence fishermen, before they return from the
17 open sea to the hatcheries.

18 In sum, there is a reasonable basis for the legisla-
19 ture to wish to proceed carefully in a new and complicated area
20 of development, such as finfish farming, because of the many
21 environmental, land use, allocation, and economic concerns. The
22 moratorium operates evenhandedly on all, and does not allow cer-
23 tain classes of people to develop finfish farms and others not
24 to. Commercial finfish fishermen and operators of nonprofit
25 salmon hatcheries are situated very differently from individuals
26 who might be interested in developing commercial finfish farms.

1 Thus, the state's motion for summary judgment on the equal pro-
2 tection claim should be granted.

3 IV. CONCLUSION

4 For the above reasons, the state asks that plaintiff's
5 October 11, 1988, motion for summary judgment be denied, and
6 that the state's motion for summary judgment be granted.

7 DATED: *October 26, 1988*

8 GRACE BERG SCHAIBLE
9 ATTORNEY GENERAL

10 By: *Larri Irene Spengler*
11 Larri Irene Spengler
12 Assistant Attorney General

13 This is to certify that on this date a
14 copy of the foregoing is being caused to
15 be mailed to plaintiff at the following
16 address:

17 P.O. Box 100682
18 Anchorage, AK 99510

19 *Dorian L. Morris* 10/26/88
20 Dorian L. Morris Date

1 IN THE SUPERIOR COURT FOR THE STATE OF ALASKA
2 THIRD JUDICIAL DISTRICT AT ANCHORAGE
3

4 DANIEL DENARDO,)
5 Plaintiff,)
6 vs.)
7 STATE OF ALASKA,)
8 Defendant.)
9

3AN 88-6467 Civil

10 ORDER

11 IT IS ORDERED that the state's motion for summary
12 judgment in this case is granted.

13 DATED; _____
14
15

16 _____
17 Rene J. Gonzalez
18 Superior Court Judge
19
20
21
22
23
24
25
26

1 IN THE SUPERIOR COURT FOR THE STATE OF ALASKA
2 THIRD JUDICIAL DISTRICT AT ANCHORAGE
3

4 DANIEL DENARDO,)
5 Plaintiff,)
6 vs.)
7 STATE OF ALASKA,) 3AN 88-6467 Civil
8 Defendant.)
9

10 ORDER

11 IT IS ORDERED that plaintiff's October 11, 1988,
12 motion for summary judgment is denied.

13 DATED; _____
14
15

16 _____
17 Rene J. Gonzalez
18 Superior Court Judge
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MARICULTURE IN ALASKA

The unpolluted, productive waters of Alaska's many protected bays and fjords are considered ideal for many forms of mariculture. Alaska also has healthy populations of many species of shellfish, finfish and aquatic plants that could contribute broodstocks for sea farms.

Alaska's first experience with mariculture involved the experimental culture of oysters near Ketchikan in the early 1900s. There now are a handful of active oyster farms in Southeast and Prince William Sound.

Blue mussels also have been successfully cultured at Halibut Lagoon in Kachemak Bay. Juvenile mussels are collected from the wild and grown on longlines or from rafts.

The State of Alaska recently entered into an agreement with the Japanese Overseas Fishery Cooperation Foundation to test the feasibility of collecting and farming weathervane scallop on Kodiak Island, and the growing of giant kelp (*Macrocystis*) at Sitka. The scallop project involves several private "cooperators" who will conduct operations at various locations around the island.

The state also is cooperating in a National Marine Fisheries Service experimental project to examine the biological feasibility of farming salmon on Baranof Island in Southeast. Growth performance during the experiments suggests that six to nine pound (market range of most farmed salmon) chinook salmon can be produced in three seasons.

Interest in mariculture has been growing in Alaska over the past few years. When a diverse group of Alaskans examined issues related to mariculture for the state in early 1986 it supported immediate development of farming operations for shellfish and aquatic plants. Voicing concern about the potential socio-economic impacts upon Alaska's important fishing industry, the group suggested that market impacts of farmed salmon be more closely examined before allowing the pen-rearing of finfish.

POLICY ISSUES RELATED TO MARICULTURE DEVELOPMENT

Legal/Regulatory Status—The legal status of mariculture in Alaska is uncertain. While it is now possible to obtain a fish farming license, changes in state law or passage of new regulations would be necessary before individuals could engage in most mariculture activities. The only clear existing permitting process currently available is for the farming of oysters. However, it is possible to obtain permits to commercially harvest some juvenile native species and to grow them to a commercial size. State law prohibits state and private non-profit salmon hatcheries from selling surplus eggs to fish farmers.

Disease and Genetics—Some concern has been expressed that mariculture could result in the spread of disease to wild stocks. However, a 1986 study prepared for the University of Washington said there is no evidence to indicate this has ever occurred. "While fish held in culture are likely to show more frequent appearance of disease than wild fish," the study said, "disease does not appear to be transmitted to wild populations." Similarly, the study said, there is no evidence to support concerns that escapes of cultured organisms will lead to interbreeding with wild stocks and cause genetic problems.

The State of Alaska has taken a cautious approach on disease and genetic issues in development of Alaska's ocean ranching program, and this is likely to continue with mariculture. Sea farming activities will fall under the state's disease and genetic policies.

Environmental Effects—Mariculture operations appear to have a small effect on water quality beyond the immediate vicinity of the culturing facilities. Potential problems would be posed only in areas of extremely limited flushing action (tides or currents) or if culture density was very great.

Concerns also have been voiced about sedimentation under floating mariculture facilities. Shellfish culture generates relatively small amounts of solid waste, while salmon farming can produce fairly large quantities of unutilized feed and feces which settle to the bottom. This sedimentation can result in major changes to the ocean floor. However, the materials are deposited in the immediate vicinity of the culturing facility and the effects are localized.

Sedimentation and water quality issues can be addressed

with the use of siting criteria to ensure proper flushing action. Mariculture operations will be monitored by state water quality enforcement programs and must comply with provisions of the federal Clean Water Act.

Use of Tidelands—Mariculture is one of many potential uses of Alaska's tidelands and adjacent uplands. A major factor in the tidelands permitting process in determining whether a site will be approved for sea farming is compatibility with existing uses. Siting of sea farms generally involves obtaining approval from at least the Departments



Leif Larson displays a shipment of oyster spat (an early life stage) at a farm near Whangell.

of Natural Resources, Fish and Game and Environmental Conservation, Environmental Protection Agency and Army Corps of Engineers.

Brood Stocks—The initial growth of a mariculture industry will be shaped by availability of marine organisms in early life stages. In most mature mariculture industries, sea farmers purchase marine organisms in early life stages from hatcheries producing fish or shellfish with genetic characteristics adapted to farming conditions. However, some species, such as scallops and mussels, may depend upon continual access to wild stocks.

Acquisition of brood stocks for salmon farming would require changes in existing law. Access to wild stocks which

support other important commercial fisheries also may require statutory or regulatory changes.

Capital Investments—As a general rule, the farming of shellfish requires a smaller front-end investment than the pen-rearing of salmon or other finfish. Many shellfish operations can be family-sized businesses, while most salmon farms have 3-10 employees. The economy of scale of mariculture operations in Alaska is unknown at this time. Japanese shellfish farmers achieve economy of scale through the use of cooperatives for processing, transportation and marketing.

Paralytic Shellfish Poisoning—Paralytic shellfish poisoning (PSP) is a serious health concern in many wild and farmed shellfish. The state requires that many species of shellfish be certified before sale. Farmed shellfish must be pulled out of the water and quarantined while samples are flown to a laboratory in Palmer for analysis prior to sale.

Tidelands Leasing—The state's current tidelands permitting process allows shellfish farmers to obtain one-year use permits. Long-term leases also may be obtained, but the surveying and appraisal process required is expensive and time consuming. The one-year permits do not provide farmers with the assurance that they will obtain the site in subsequent years and may not be used as security for loans.

Economic Impacts on Commercial Fisheries—Many commercial fishermen and processors are concerned about the impact of salmon farming on the world market price for salmon. A 1986 study by the University of Alaska's Marine Advisory Program concluded that salmon farming worldwide "may immediately impact only a small portion of the Alaskan salmon industry." However, the study went on to say, the growth of salmon farming throughout the world suggests these trends should be watched closely.

The Alaska Department of Commerce and Economic Development is gathering comments on mariculture development from various coastal communities for consideration by the 1987 legislature. During these "town hall" meetings, the department will present information outlining potential effects in Alaska from a range of mariculture development scenarios. Included in the report to the legislature will be an analysis of the potential impacts on existing salmon markets from additional Alaska supplies (wild and farmed sources) of chinook and coho salmon.

WHAT IS MARICULTURE?

Mariculture is the farming for profit of shellfish, finfish and sea vegetables in the marine environment. The organisms to be cultured are produced in hatcheries or gathered from the wild. The growing takes place in net pens, from rafts, longlines, and on the ocean floor or intertidal area. In some cases sea water is pumped to shore-based enclosures. Some of the more common mariculture products are scallops, shrimp, salmon, mussels, nori and kelp.

This captive culture is distinct from Alaska's existing **ocean ranching** program which involves raising salmon to the juvenile stage for release to intermingle with wild stocks. Ocean ranching in Alaska is conducted on a private non-profit basis or by public agencies. The returning salmon must contribute to the common property fisheries (commercial, sport, subsistence and personal use).

A more encompassing term is **aquaculture** which includes mariculture, ocean ranching, and farming in fresh water with such species as catfish, shrimp, trout and crayfish.

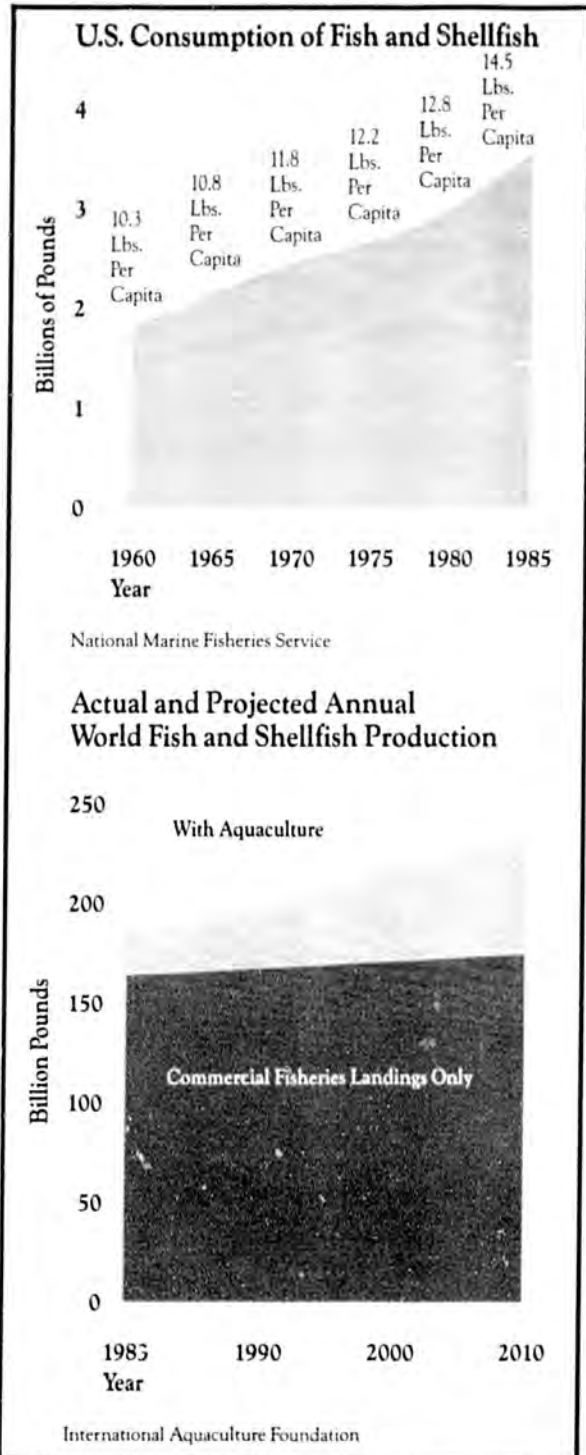
GLOBAL MARICULTURE TRENDS

Although fish farming originated in China many centuries ago, relatively recent advances in controlling diseases, understanding nutritional requirements and breeding domesticated stock have led to an aquaculture explosion throughout the world.

Global aquaculture production of fish and shellfish was estimated at 22 billion pounds in 1983 and is expected to reach 48 billion pounds by the turn of the century. Aquaculture produced 12.2 percent of the world's total supply of edible fish and shellfish in 1983.

Meanwhile, production curves of commercial fisheries landings have flattened out. While aquaculture production is expected to rise by 5.5 percent annually over the next 25 years, the annual increase for wild fisheries is expected to be .3 percent.

The increases in production of cultured fish and shellfish correspond with a steady growth in seafood consumption throughout the world. These trends are readily apparent in the United States where consumption of fish and shellfish climbed by 609 million pounds or 21.5 percent between 1982-1985.



HOW TO OBTAIN ADDITIONAL INFORMATION ON MARICULTURE

Department of Commerce and Economic Development

Bill Paulick
Office of Commercial Fisheries Development
Department of Commerce and Economic Development
P.O. Box D
Juneau, Alaska 99811
(907) 465-2162

Department of Fish and Game

Mike Kaill
Fisheries Rehabilitation, Enhancement and Development
Department of Fish and Game
P.O. Box 3-2000
Juneau, Alaska 99802-2000
(907) 465-4160



MARICULTURE IN ALASKA

Department of Commerce and Economic Development
Office of Commercial Fisheries Development

Steve Cowper, Governor
State of Alaska

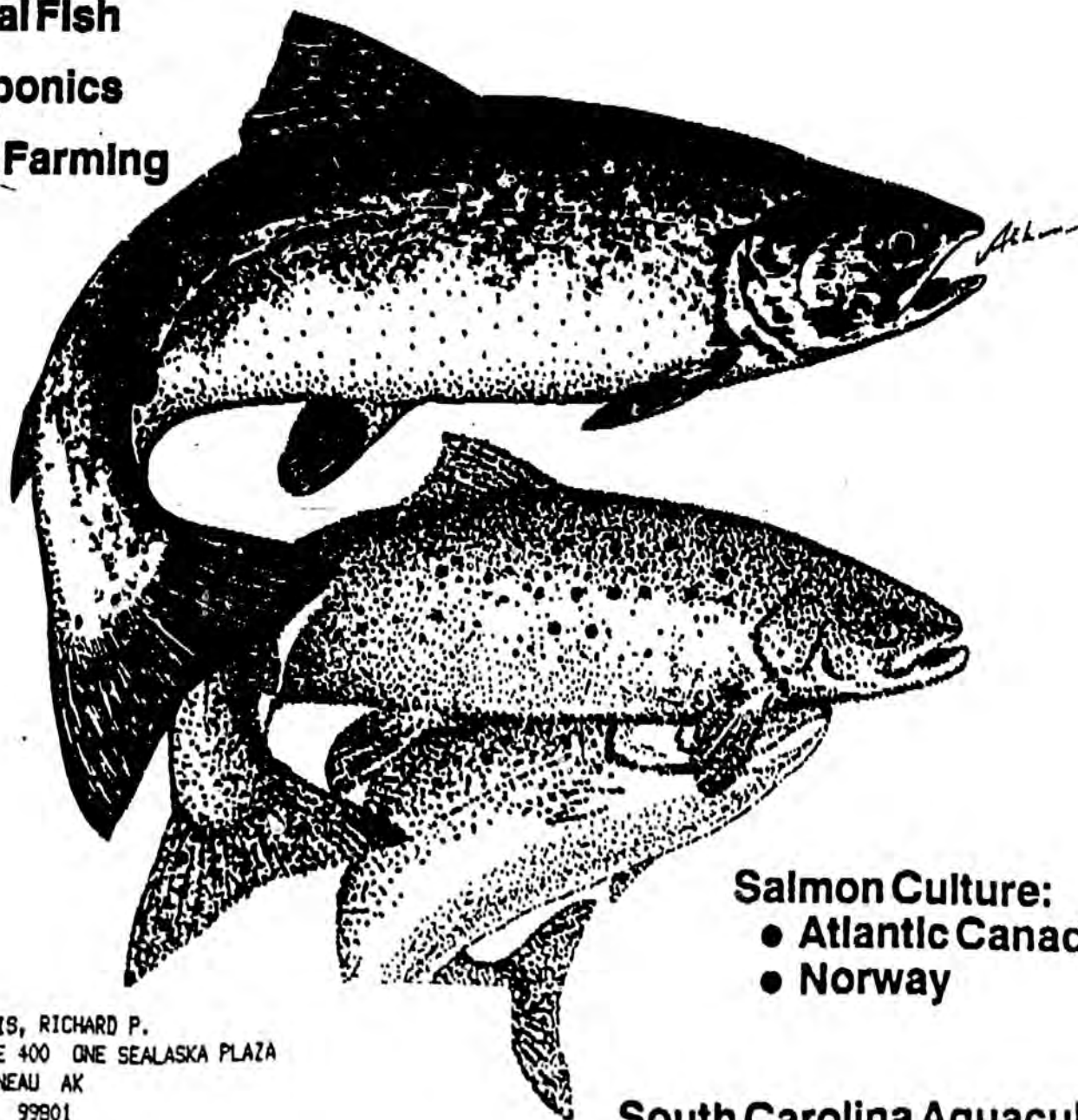


A DISCUSSION OF THE
ISSUES INVOLVED IN
SEA FARMING DEVELOPMENT
IN COASTAL ALASKA

Vol. 20(3)

WORLD AQUACULTURE

Tropical Fish
Hydroponics
Turbot Farming



Salmon Culture:
● Atlantic Canada
● Norway

September, 1989

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South Carolina Aquaculture

the economics of

Salmon

farming in the Bay of Fundy

Text by Dave Aiken

Photography by Bill McMullon

The Atlantic salmon has always been "The King of Salmon" in the Maritime provinces of Canada. From the prehistoric Algonkian Indian fishermen to the modern farmer growing salmon in sea cages in the Bay of Fundy, *Salmo salar* has been a potent economic force.

The upscale Canadian market for Atlantic salmon was once supplied by Maritime fishermen who netted the noble fish when they returned to their ancestral rivers to spawn. But the numbers of wild fish eventually declined to dangerous levels, and the federal government was forced to end the commercial harvest. That shut off domestic sources of *Salmo salar*, and for the first time in history Maritimers had to go offshore for their Atlantic salmon.

Then in 1978 Dr. Arnold Sutterlin, a research scientist with the Canadian Department of Fisheries and Oceans, convinced federal, provincial and private interests to test his theory that Atlantic salmon could be farmed in sea cages in the southern Bay of Fundy. Earlier attempts by others had been terminated by "superchill," literally the freezing to death of salmon that occurs when the temperature of seawater declines to minus 0.7°C.

But Sutterlin insisted this was not an insurmountable problem. He knew that temperatures in the open Bay of

Continues...



Fundy remained comfortably above the lethal level throughout the winter, and that lethal chilling probably occurred only in the shallow and protected coves and inlets around the perimeter of the Bay. Unfortunately, it was those coves and inlets that offered the protection required for salmon sea cages. The terrible winter gales and intimidating seas of the open Bay of Fundy would make short work of salmon cage designs available in those days, and therein lay the conundrum: in the open Bay where the salmon could survive, their cages could not. In protected coves where the cages could survive, the salmon could not.

Sutterlin and his colleagues focused on the Fundy Isles region in the south-western Bay of Fundy. Here a string of islands form a broken barrier between the fearsome open water of the Bay of Fundy and the sheltered, shallower and significantly cooler water of Passamaquoddy Bay. Among the islands powerful tidal currents surged twice a day, driven by tides with a vertical range of more than eight meters. Here coves, inlets and channels offered protection from winter gales and destructive seas, protected sites where water temperatures were moderated

by warmer water from the adjacent Bay of Fundy.

In one of these, on the outer coast of Deer Island, eastern Canada's first commercial sea cage salmon farm was established in 1978. With technical expertise and funding from the federal and provincial (New Brunswick) governments, and other contributions from a private company, 3,800 salmon smolt were stocked in a 12-meter octagonal cage similar to those used in Norway.

As the winter of 1978 deepened and seawater temperatures in many areas sank below the lethal level, the team watched their livestock not only survive but grow. The following autumn 6.3 metric tons of prime Atlantic salmon were harvested from the cages, establishing the validity of Sutterlin's theory and the viability of net pen salmon culture in the southern Bay of Fundy.

History

From that modest harvest in 1979 the industry has grown at an impressive rate, roughly doubling its harvest in each successive year. There are now 44 approved cage sites and roughly 40 active farms scattered throughout the Fundy Isles region of New Brunswick

from Grand Manan northeastward past St. George and Beaver Harbour.

The development of the industry on the Atlantic coast contrasts sharply with the history of the "BC" industry on Canada's west coast. The Pacific industry has been heavy on promotion and a bit light on performance; the Atlantic industry, on the other hand, has developed quietly but steadily, building on performance rather than promotion. Where the Pacific industry leaned toward public companies and venture capital, the Atlantic industry developed through small partnerships and more conventional financing. Where the Pacific industry focused on coho and chinook salmon — both difficult species to cultivate — the east coast industry farmed the cooperative and dependable Atlantic salmon.

Sutterlin's group provided the inspiration and basic technology for Fundy salmon farms, but several other factors combined to make the industry what it is today. Take smolt, for example. To run a salmon farm you must have smolt, and to have smolt you must have broodstock; the well known chicken-and-egg situation. Fortunately the federal government had been producing smolt for years to enhance wild stocks, and they annually produced a small surplus that could be

The Deer Island Story

To start a new industry you must have good timing, the required resources, and dedicated people. This is a story about two such dedicated people.

To those of us who know and worked with them in the late 1970s, Arnold Sutterlin and Eugene Henderson were that rarest of species — dedicated government scientists with a vision. Aquaculture was not a household word in those days. In government research circles it was not even a popular word, but to "Arnie" and "Gene" it mattered not. They were determined to prove that salmon could be overwintered in the Bay of Fundy and that a viable salmon culture industry could be established in the area. A site was carefully selected on the outer side of Deer

Continued next page



Arnold Sutterlin (right) and Eugene Henderson, part of a team that in the late 1970s helped make Bay of Fundy salmon farming a reality, discuss old times at the second St. Andrews Atlantic Aquaculture Fair. Sutterlin was honored with the "Aquaculturist of the Year" award in recognition of his early contributions to the local salmon industry.

Deer Island Story

(from previous page)

Island, one of the Fundy Isles that rim the western side of the Bay of Fundy, the "Deer Island Project" was born, and the rest, as they say, is history. Their vision and hard work helped establish an industry that last year grossed about \$40 million in direct sales and employed about 170 people.

Sutterlin and Henderson were the quintessential match of opposing personalities. Sutterlin was a free spirit whose creative mind could never fully accept the constraints of bureaucracy with its penchant for detailed reporting of minutiae and endless forms filed in triplicate. Henderson, in contrast, was a detail man, patient and meticulous. Sutterlin was the one who cut the swath but it was Henderson who gathered, bundled and stacked. Together they accomplished much more than the simple sum of their labors.

It also helped that both could endure long hours and hard physical work, a trait that was put to the test during the long summer days of 1978 when those first cages were being prepared for the crucial test — a winter on the fringe of the notorious Bay of Fundy.

As a government scientist Sutterlin was expected to focus on commercial species, but his naturally curious nature frequently diverted him to such esoterica as hagfish, sea cucumbers and tomcod, none of which appeared on any list of government research priorities. Chafing for the freedom to pursue his inclinations, he left the government in September of 1978, and was soon exploring the wonders of mussel farming, trout farming, lobster holding systems, and marine fish farming.

Sutterlin's departure from government research came just as his Deer Island project was heading into its first crucial winter, and it left the project without a chief scientist. Typically, Gene Henderson took control of everything from animal husbandry, food preparation and on-site data collection to searching for a source of funds to carry them through the following summer. Salvation finally came

Continued next page



Harvesting Atlantic salmon from sea cages in the Bay of Fundy is cold, wet and hazardous. Late in the year winter gales sweep the cage sites and walkways become ice-coated from freezing spray.

used to start the industry. However, the fact that it was a small surplus prevented the industry from expanding prematurely; there simply weren't enough fish available in the early years to support a reckless expansion.

Site limitation was another factor. The threat of superchill and an early uncertainty about many otherwise suitable farm locations restrained development. So did the ultraconservative financial community, which wasn't eager to advance large sums of money on an unproven enterprise that, even if successful, would operate with a negative cash flow for two or three years.

Finally, there was the moratorium. Just as salmon fever was about to erupt among Bay of Fundy entrepreneurs, the Province of New Brunswick clapped a moratorium on new leases. That lasted for two long years during which world production of farmed salmon soared and market pressures finally came to bear. The moratorium was lifted early this year, but the signs of softening world prices were unmistakable for astute observers.

Industry Profile

In 1987 there were 28 active farms in the Fundy Isles region with fish in 525

cages, 447 of which contained salmon for market. An additional 13 held broodstock salmon (11 additional cages contained rainbow trout and 54 were empty). From these 447 "production" cages roughly 341 thousand salmon were harvested, and their value was approximately US\$12-14 million. The 1988 harvest was close to 3,600 mt, worth roughly US\$32 million.

The industry in 1987 consisted of a high proportion of small operations. Only ten percent had more than 50 cages in the water (the largest had 70), and nearly half were operating with fewer than 8 cages, each containing an average of 2900 fish. A medium sized Fundy salmon farm in that year had 24 cages in the water and employed ten people, three of which worked part-time. A farm of this size could have annual sales of approximately one million US dollars, and required roughly US\$480,000 in working capital.

Fundy salmon farming is now a maturing industry that has been in operation long enough to generate reliable numbers on capital and operating costs, equipment and employment requirements, and revenue expectations. It is also possible at this point to estimate the auxiliary benefits, the general economic well-being that surrounds a viable and growing industry. Information of this type is seldom available on a new industry, yet it is extremely valuable for individuals contemplating entry to the industry. It is also useful for the financial institutions that are asked to provide funds to the industry,

Typically, neither Sutterlin nor Henderson has profited financially from the industry that developed from their dedication and hard work, and neither seems the least disturbed by that fact. Apparently it is sufficient that the cages are there, the fish are growing, and that each autumn and winter tonnes of the finest salmon available in the world are harvested from the Pundy Isles region of the Bay of Pundy, a place that Sutterlin and Henderson helped put on the map. •

Market crisis

As world production soars the market for salmon softens and prices plunge, bringing chaos to the British Columbia industry and the promise of big changes in the global picture.

The fact that it was inevitable in no way softened the impact of this summer's precipitous decline in world salmon prices.

Fingers seem to be pointing toward Norway as the cause of the price slide, but in fact Norway is only a part of the underlying problem — the incredible explosion in salmon production world-wide. Chile, Iceland, and the Faroe Islands have come on stream as significant producers, augmenting the major production increases that have occurred among most of the established producer countries. This year the world-wide supply of farmed salmon was expected to jump 60-80% over last year's already impressive output, while market growth was expected to slow to 40-50%.

At the forefront of the crisis was Norway. Last year Norwegian farms produced 89,000 mt. Spectacular as that was, they projected a major increase to 120,000 mt for this year. Spectacular as that was, it proved to be too low and had to be revised upward to 150,000 mt when a mild winter combined with increased survival produced a better than average crop. Shortly after that prices began to slide, squeezing profit margins and triggering a cascade of reactions that included early harvesting by cash-starved farmers, further price depression and finally intervention by financial institutions.

Norway's influence in the industry is not restricted to the production of salmon. Norwegian banks have been active in financing salmon enterprises outside of Norway, and the industry in British Columbia is indebted to Norwegian banks to the tune of an estimated C\$70 million.

The price for chinook on the Seattle market tumbled from U\$9.90 a kilo in April to only U\$5.05 a kilo by the end of June, and B.C. salmon farming concerns — the majority of whom will bring their first major harvest to

Continued next page...

to entrepreneurs who might consider becoming involved on the support side, and to governments that are trying to keep the new developments in proper perspective.

Recognizing this, federal and New Brunswick provincial governments jointly commissioned a detailed economic study of the Fundy industry by Fiander-Good Associates. Their analysis, published in 1988, provided an excellent overview of the industry through 1987. The following economic profile draws heavily on their findings. All values are expressed in United States dollars, assuming the Canadian dollar to be worth US\$ 0.80.

Economics

The new salmon farmer, stocking his cages with smolt for the first time, faces 18-20 months without income while the livestock grow to harvestable size. During this period the fish must be fed and maintained, so a significant amount of working capital will be required. To operate through the second year a line of credit approaching \$600 thousand might be required.

The farmer starting with 8 cages of 2500 smolt each and expanding to 24 cages within three years can incur a loss of \$254 thousand in the first year, but harvesting late in the second year combined with income tax adjustment from the first year should produce substantial earnings. By year-5 gross earnings should be stabilizing at nearly a million dollars a year with after-tax profits of roughly \$250 thousand.

Profitability will continue at this level unless conditions change and if there is a change, profitability will be altered according to the relative sensitivity of different components of the culture system. For example, the economic viability of salmon farming is considered *highly sensitive* to changes in the selling price and mortality rate of fish, *moderately sensitive* to changes in feed costs, and *relatively insensitive* to changes in smolt costs.

● **Selling Price.** In 1987 the standard sale price was \$10.55 per kilo. In 1988 market pressures forced this down to \$8.80 per kilo, resulting in a 35% decline in annual net income. This degree of change indicates the system is relatively sensitive to changes in selling price.

Under these conditions cash flow for a new farm becomes slightly negative in the second and third years of operation. If the selling price were to drift down to only \$7.00 per kg, net income would be reduced by 70%, producing a strongly negative cash flow in years 2 and 3, and delaying payment of income tax to the fifth year. This situation would greatly increase the amount of financing needed to provide adequate working capital.

● **Mortality.** The current standard is 16% mortality from stocking to harvest. If this were to increase to 25%, net income would decline by 18%. However, reducing the mortality rate to 10% (a realistic expectation) would increase annual net income by 12%.

● **Feed Costs.** At the 1987 price of 72 cents per kg, fish feed consumed more than 30% of annual operating costs. However, if the feed price were to increase to 90 cents per kg (a 25% increase), net income would be depressed by 8%, suggesting the salmon culture system is moderately sensitive to changes in feed costs. Fortunately, the feed industry is highly competitive and prices have remained stable for the past three years.

● **Smolt Costs.** The annual purchase of 30,000 smolt (12 cages at 2,500 per cage) at the 1987 price of \$2.40 per fish represented 15% of annual operating costs. In 1988 the price rose to \$2.80, and in 1989 to \$3.20. At \$3.20 per fish, net income declines by only 5%. An increase to \$4.00 (23% of operating costs) would produce only a 23% decline in net income, so salmon cage culture can be considered relatively insensitive to changes in smolt prices.

Capital Costs

The capital cost of establishing a 24-cage salmon farm in the Bay of Fundy in 1987 varied from \$215 thousand to almost \$600 thousand depending on the type and size of cage selected. Over a ten year period the total capital requirement, including replacement of equipment, could range from \$400 thousand to almost a million dollars. These costs are made up of everything

Prices (previous page)

market this year — could see only darkness at the end of the tunnel. For those farms still struggling to recoup their heavy initial investment, the prognosis was not good.

Hardy Sea Farms Inc. was one of the first to go, with control being assumed by a subsidiary of Bergen Bank. Others would follow, and the net result will likely be a major restructuring of salmon companies in B.C. The general feeling is that a lot of assets will change hands as a result of the current squeeze, but there is not likely to be any significant reduction in total production capacity.

One positive thing that may come out of the current crisis is a revamping of the B.C. industry's marketing procedures, which to date have been less than satisfactory. European producers have developed sophisticated marketing and distribution systems to cope with the nuances of the export trade. Norway, for example, funnels fish from its 500 farmers through a single export agency, but B.C. farmers have been selling their product through a six-city United States distribution network that was geared to an annual 3-month wild fishery. This, in the opinion of some, is largely responsible for the magnitude of the current problem in B.C.

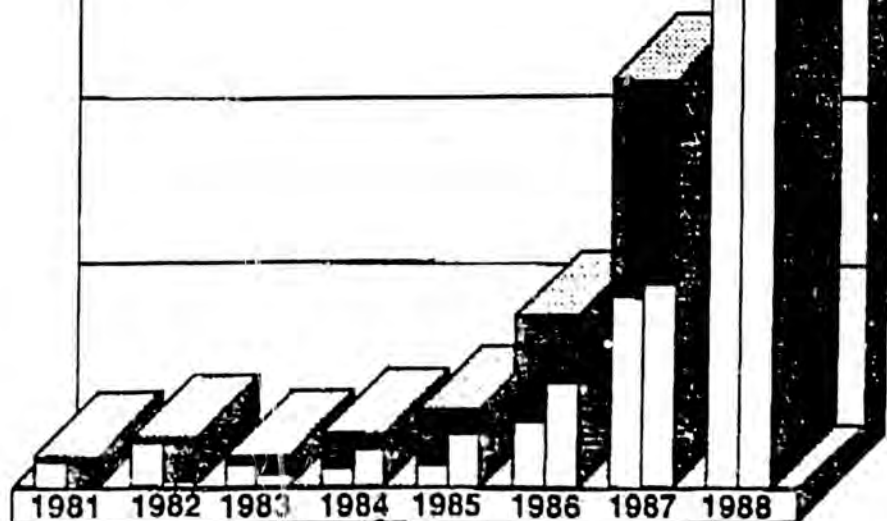
Meanwhile, the Norwegians are making some adjustments of their own that are contributing to the evolution of the global industry. Recognizing the difficulty of competing effectively on the North American market, the Norwegians have set their sights on Japan, the world's largest consumer of salmon. In addition, Norway will probably freeze a large part of this year's production, making it more attractive for the European market.

Whatever the outcome — and there are several major players still to be heard from — it is clear that the character of the global marketplace for salmon is undergoing major change, and the capture fishery will probably be affected as profoundly as the culture fishery. In short, the salmon industry has become a full fledged, highly competitive global industry, and those who hope to survive had better recognize that fact and adjust to it. ●

Ten year production history from salmon farms in British Columbia (Pacific) and the Bay of Fundy (Atlantic)

YEAR	Production (MT)			Value US\$000
	B.C.	N.B.	TOTAL	
1979	41	6	47	165
1980	157	11	168	784
1981	176	21	197	913
1982	273	38	311	1,181
1983	128	68	196	1,106
1984	107	222	329	2,620
1985	120	349	469	4,014
1986	397	635	1,032	8,782
1987	1,200	1,315	2,515	19,932
1988	6,000*	3,600*	9,600*	85,000*

*Unofficial figures





from cages and predator nets to moorings, boats and buildings.

Simple wood-frame rectangular net pens can be constructed for as little as \$3,200 but the life expectancy of these cages is only five years. The octagonal Malloch cage (designed by pioneer salmon farmer John Malloch), was an early favorite in the Fundy Isles region. A complete Malloch pen constructed of local spruce timber and equipped with a predator net could be floated for roughly \$4,800.

Many of the farms are changing to larger and more expensive plastic or galvanized steel cages. A heavy duty

galvanized cage almost 12 meters on a side has a volume of nearly 545 cubic meters and, at 8 mt of fish per cage, will hold livestock conservatively valued at \$65,000. These cages will last at least 15 years but are correspondingly more expensive (\$10-\$15 thousand). Some farmers have switched to a 23-meter circular plastic cage and others have replaced their Mallochs with a 12 x 12 meter cage constructed of PVC. These will carry 20% more smolt than the Malloch but they also cost considerably more (over \$7000).



Cages in the Fundy industry carry two types of net: a livestock net that has a mesh of 28-55 mm, and a heavy predator net with a mesh of 20 cm to keep seals and cormorants out of the cage. Nets can vary in price from \$800 to \$2400 depending on size, material and coating, and nets for the average sea cage cost \$3,500-\$4,000 in 1987. Moorings to secure the cages and boats to service the facility add another \$24-32 thousand.

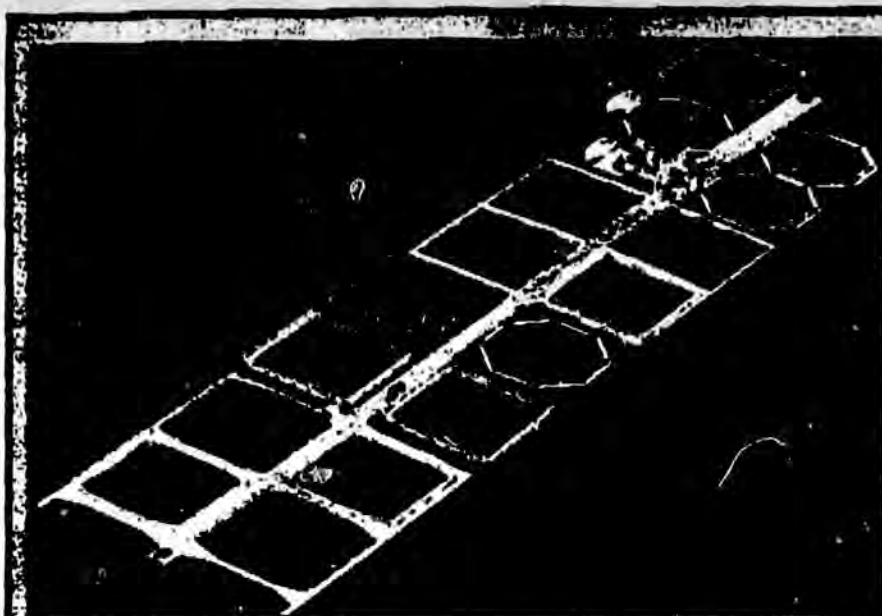
Operating Costs

Annual operating expense for smolt, feed, labor, insurance and other items on a 24-cage farm ran close to \$475 thousand in 1987. Roughly 15% of the total was spent to purchase smolt (\$70 to \$75 thousand).

Food for the growing salmon is a major expense, upwards of \$146,000 for a 24-cage farm in 1987, or 31% of total operating expense. In the Fundy industry 80% of the feed has been a moist formulation supplied by a local manufacturer, who delivered 6 days a week for 73-77 cents per kg. Feed conversion ratio over the 18-month growout period has been running at 1.5 to 2.0 kg of food supplied for each kg of fish produced (often called FCR and expressed as 2:1 or simply 2), which at 1987 prices represented an annual feed cost of \$3.23 per fish.

The 24-cage Fundy farm requires a full-time manager, four to six full time employees and one to three part-time employees. Average wage for laborers in 1987 was \$6.54 per hour, but ancillary costs increased the wage burden to an average of \$7.38 per hour, or \$15,360 per person-year. The full-time manager cost approximately \$32 thousand per year, raising total employment to approximately \$145 thousand, or 31% of total operating costs.

The Fundy Isles region in the vicinity of St. George's, New Brunswick. Myriad small islands provide a barrier against the tumultuous winter seas of the open Bay of Fundy, while providing access to the more moderate water temperature from the Bay. Currents associated with tidal amplitudes of 8-9 meters surge past the cages four times each day, assuring abundant oxygen, pure water and Atlantic salmon of the highest quality.



Salmonid Demonstration Farm

Extension services and training facilities are extremely important in agriculture and aquaculture, especially when the technology is new or there are a lot of new entrants to the industry. Agriculture has developed an excellent extension capability in North America, but services have been much more limited in aquaculture.

The Fundy Isles salmon farming industry got a major jump on this problem with the establishment, in 1985-86, of a commercial scale experimental salmon farm in the heart of the Fundy Isles industry.

The farm was funded by the federal government, and its experimental program was developed annually with approval from a steering committee that consisted of representatives from industry and the federal and provincial governments. Early trials focused on diet formulation, broodstock development and on ways to improve the rate of growth. Data developed at the Farm served, in a way, as a standard against which all farms in the Fundy Isles region could measure their own achievements.

The Demonstration Farm also became an important element in the Salmon Genetics Research Program, a joint scientific program of the Atlantic Salmon Federation, through its research facilities near St. Andrews, and the local federal laboratory (the Biological Station). This program is

involved in the development of four strains of Atlantic salmon, two for sea ranching and two for cage culture.

Unfortunately, federal funding expired this spring, and since then a lot of local effort has been expended just trying to secure a future for the Demonstration Farm. Ownership has been assumed by the New Brunswick Salmon Growers Association, but most of the equipment is still owned by the federal Department of Fisheries and Oceans. That Department and the NBSGA signed an agreement to keep the Farm operating (some 20,000 smolt are in the water) on a temporary basis, hopefully until some long term funding arrangement can be developed.

As part of the upheaval the Farm lost its existing water site and was forced to relocate to a new site almost a kilometer away from its land-based facilities. Gene Henderson, general manager of the Demonstration Farm, was recently appointed general manager of the New Brunswick Salmon Growers Association, and it will be his responsibility to deal with the many problems currently facing the facility.

The major concern behind all the maneuvering is the possibility that an important facility for technology transfer and training in the science and art of salmon farming will be lost to the Atlantic region. •

Many farms in the Bay of Fundy carry some insurance against loss. Insurance of livestock without superchill coverage typically costs about 5% of the covered value and averages about \$20 thousand. In addition there are costs for processing and marketing the product, typically about \$58 thousand. Fuel costs will be roughly \$13 thousand, and electricity can add another \$6,500. Small things can add up to a surprising amount in such an operation. The ice used to quick-chill salmon at harvest costs only \$1.60 per kg, but since 5 mt are required for each cage harvested, a 24-cage farm would spend more than \$2 thousand on ice each year.

Revenues

Salmon farms derive revenues from two major sources: marketing of fish and sale of eggs. Each broodstock female can produce 275-365 eggs per kilo of fish weight, and the assumed industry average is 10,000 eggs per female. In 1987, green eggs were worth 6-7 cents each, which means each broodstock female was expected to produce \$600-700 worth of eggs. The total broodstock inventory in 1987 probably produced 17 million eggs, worth more than a million dollars. In 1988 nearly 26 million eggs were anticipated, and these should have brought in nearly \$1.7 million.

At harvest the average salmon weighs just over 3.6 kg but may range from just under 2 kg to well over 5 kg. Smaller salmon (less than 3.2 kg) often sell for less than the standard price, and those heavier than 5 kg often command a premium. For the average 24-cage farm at full production in 1987, harvesting 12 "standard" cages of fish per year, revenues should have approximated 970 thousand U.S. dollars, or more than \$80 thousand per cage.

Spinoff

A major industry requires a variety of products and services, and these are usually supplied by individuals and small companies in the area. Sometimes the total economic benefit from this spinoff can equal the direct employment and operating revenues from the major industry. Fundy salmon farming has spun off three obvious satellites: smolt production



Walter Balasluk and George Wolf of Jall Island Salmon Ltd. pack freshly harvested Atlantic salmon for shipment to market. The fish are dressed, washed and quick-chilled to 0°C, packed in styrofoam containers that contain about 27 kg, and loaded on refrigerated trucks for the 7 hour trip to Boston (or same-day air shipment to Canadian markets). Until 1987, 80% of the harvest stayed in Canada, but the majority of the harvest now goes to consumers in the United States.

(hatcheries), feed manufacturers and equipment manufacturers.

The industry was severely restrained in the early days by a shortage of smolt, but private industry rallied, and in 1987 over 900 thousand smolt were made available by eight private, one non-commercial and two federal hatcheries. Sea Farm Canada, with three hatcheries, was the largest supplier of smolt in an industry that employed more than 40 persons and paid more than \$600 thousand in wages. In spite of the expanded capacity the industry has never had enough smolt to service the demand (the 1989 shortfall was 250-300,000

smolt). Within the industry there is concern that the loss of one of the three major suppliers could create havoc within the industry.

In the feed industry alone 40 person years of employment and over a half-million dollars in wages could be attributed to the salmon industry in 1987. Cage fabrication added another 4 person years and \$50 thousand in wages, and miscellaneous related activities (moorings, packing boxes, flotation, marketing services) added another 70 person years and \$390 thousand in wages. All told the ancillary industries employed 114 persons in 1987 and paid out \$1.56 million in wages.

Future

Although some 40 sites are currently occupied in the Fundy Isles region, surveys indicate the entire Bay of Fundy offers no more than 60-70 sites that have the necessary protection from storms and access to safe winter water temperature. The Bay of Fundy salmon industry is therefore site-limited by current technology, but even 60-70 sites could theoretically

produce 12,600 mt annually which, at current prices, should be worth more than US\$ 100 million, a significant infusion of cash for an area that has been economically depressed.

Alternatives to the current site limitations are being examined. Land-based farms are one solution and open water cage systems are another, but both are costly alternatives. In the end the profit margin will determine the extent of innovation the industry can tolerate.

The 1989 harvest from the southern Bay of Fundy should approach 4100 mt but a major increase is expected in 1990 (2.2 million smolt stocked in 1989 should yield upwards of 7,500 mt in 1990). However, the value of the harvest in future years will depend on how the world market develops. There seems little question the industry is in for a period of instability and adjustment, out of which should emerge a different but stronger industry in which ownership is more consolidated, the profit margin is narrower, farming operations are more efficient and the market is more effectively exploited. ●

Dave Aiken and P.W.G. (Bill) McMullon are with the Canadian Department of Fisheries and Oceans at St. Andrews, New Brunswick.



Bill McMullon has been photographing Canadian fisheries and aquaculture developments for years. His work appears frequently in this magazine.

Norway

The Norwegian Fisheries Industry from Capture to Cultivation

by Bjarne Mark Eidem

Some years ago an old fisherman I know in Northern Norway went into aquaculture. In explaining his reasons for going into this new field he said, "We have harvested the sea for thousands of years; now the time has come to plant some seeds."

The fishing industry is really no further advanced than were the hunters and gatherers of a thousand years ago, moving from one area to the next, harvesting the natural crop where they found it, hunting animals in the forest.

We Norwegians are relative latecomers to the field of aquaculture. Two years ago I visited China and was very impressed with what I saw. The aquaculture tradition there is thousands of years old, whereas in Norway we more or less stumbled into this field during my children's lifetime.

But we have made important advances in aquaculture in the relatively short time we have been active. We have invested great sums of money, and we have reaped the profits of this investment. And yet, what we have seen so far is only the beginning.

I want to briefly describe the development of aquaculture in Norway, a modern industrial nation with long traditions in conventional capture fisheries, and then tell you about the difficulties we have encountered,

how we have tried to solve our problems, and what we are thinking about doing in the future. I will also look briefly at market development and the prospects for farmed salmon, since this has become a major concern, as you will see.

Aquaculture development

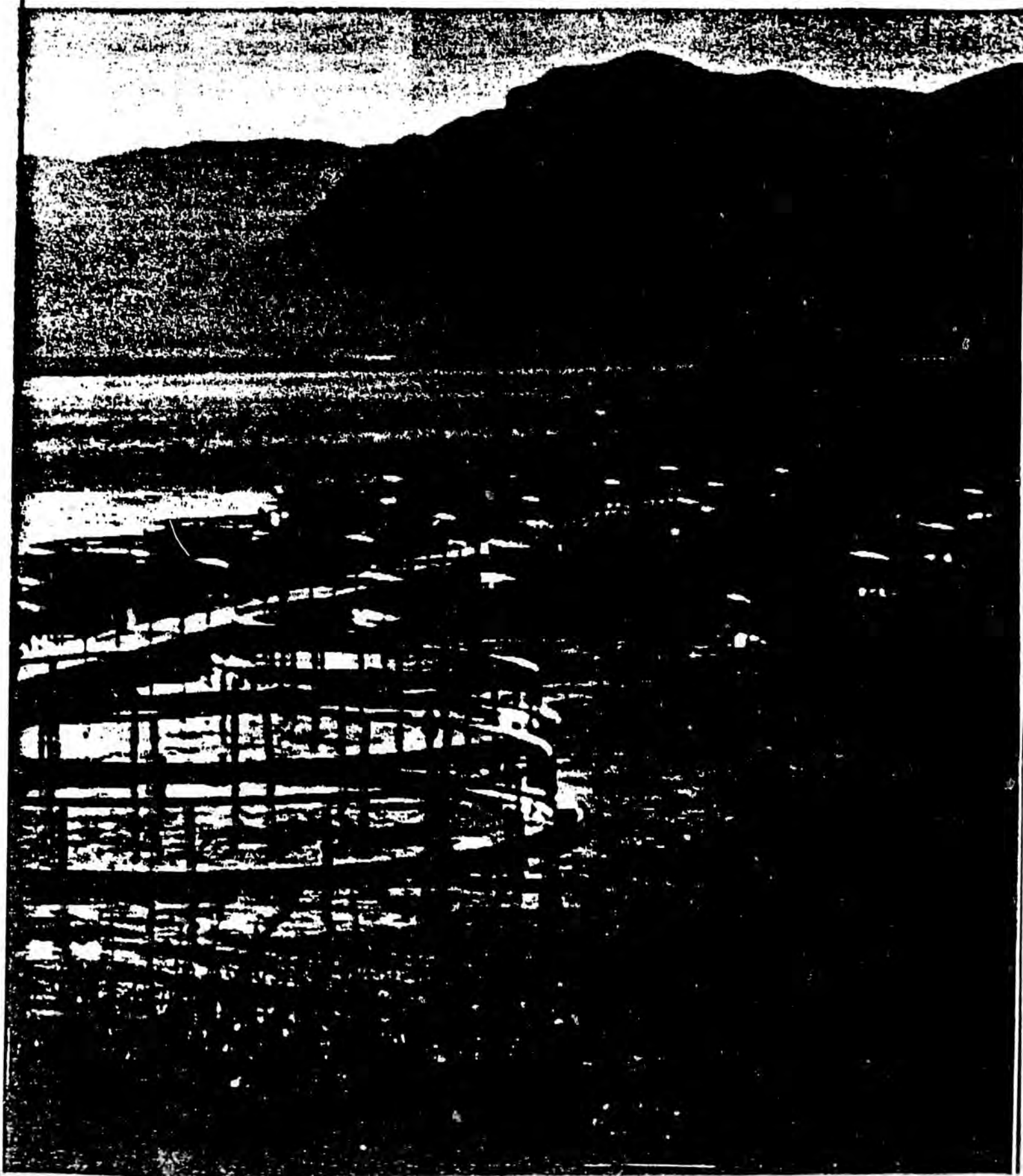
Not even the most optimistic Norwegian aquaculture pioneer envisioned the fantastic development that would occur in the industry. In the beginning they were viewed with skepticism, particularly by financial institutions.

Incontrovertible signs of success did not appear until the 1980s. Production in 1979 was only about 4,000 metric tons; nine years later, in 1988, it was 18 times that, and the growth continues.

Salmon and trout farming is an important growth industry in Norway, and it has definite political objectives at the regional and national level (e.g. contributing to employment in rural and coastal areas). The export value of farmed salmon and trout in 1988 was more than 4.0 billion NOK, or about US\$ 615 million. The industry employs about 5,000 people directly, and as many more in related sectors.



All photographs in this article courtesy of the Marketing Council for Norwegian Salmon





Today there are some 667 hatcheries—with a total capacity of about 217 million smolt per year—and 786 grow-out farms, with a total production volume of about 6 million cubic meters. It is a bit difficult to estimate the total production capacity, since this depends on the stocking density, but experts we have consulted suggest some 200,000 metric tons per year.

Advantages

Norwegian success in salmon farming has surprised some people because Norwegians do not have a long history as fish farmers. Some Norwegians along rivers have been releasing smolt for decades, but more for

sport fishing than as an industrial enterprise.

The following competitive advantages have been identified as having helped Norway become the leading producer of farmed salmon in the world:

- A long coastline with fjords and islands that protect fishfarms from heavy weather;
- Good quality seawater at the optimum temperature for salmon, trout, halibut, wolffish and other coldwater species (the Gulf Stream ensures relatively warm and stable temperatures along the entire coast);
- Sufficient freshwater for production of Atlantic salmon smolt;
- Sufficient fish byproducts from the traditional fish industry to provide raw materials, for the fish feed industry (protein of marine origin is required for the production of a well balanced diet);
- Excellent infrastructure along the coast;
- Experience in research, production and trade in Atlantic salmon. Norwegian research has focussed on genetics, fish-feed, and diseases.

Legal framework

The Ministry of Fisheries exercises legal and administrative control over the fish farming industry, through its regional offices, which are under the jurisdiction of the Director of Fisheries.

A legal framework for the salmon farming industry was introduced in 1973 with the establishment of the first bill governing the production of aquaculture products. The system introduced with that bill was retained in the temporary act of 1981, and also in the new permanent Act Relating to the Breeding of Fish, Shellfish etc. which was passed in 1985, and which today regulates the industry.

The licensing system is the main instrument used by the authorities to maintain the fish farming industry as a profitable and viable regional industry. The system limits the maximum size of each farm, as well as the maximum number of permits given for fish farming. The number of permits has been strictly limited, but there has been considerable pressure to liberalize this (it should be noted that this limitation applies mostly to farms growing salmon and trout. For other species, a much more liberal attitude has been adopted).

In 1987, the Ministry of Fisheries issued a Parliamentary Report on Aquaculture, which provided the first broad overview of the policies. The main objectives for the industry are closely related to the major political objectives: employment, balanced regional settlement, agricultural, fisheries and industrial activities. We have learned three things from our experience with these regulations. Firstly, the rapid growth of the industry generated an overwhelming number of applications for permits, and our administrative apparatus was unable to handle them efficiently. This led to a serious delay in reviewing applications and necessitated new and more efficient ways of handling the applications.

Secondly, there were instances where different interests conflicted: economic, environmental, transportation, fishing, recreation, etc. This conflict is perhaps the most difficult to deal with, but it is also of great importance, as it involves a balanced development of different activities in our society.

Finally, we need more knowledge about this industry and about the consequences of a large scale operation. The need for more research in fields related to aquaculture is urgent. Industrial-scale aquaculture requires an advanced level of both technical and

organizational knowledge, and we realize that more work is needed in this field.

Production

Norwegian salmon farming has grown along a rising curve that has been broken only once. This break (in 1987) was due to factors we can explain, and if we look at the growth of the industry in a longer perspective, that brief stagnation is insignificant. The forecasts published by the Fish Farmers' Association early this year are optimistic, but we see no reason to revise the projections at this point, especially concerning the next two years.

Our expectations for the Norwegian salmon farming industry up to 1995 are shown in the accompanying graph. The basis for this prediction is, of course, the number of smolt set out in the grow-out pens. In 1988 we saw a record number set out, over 70 million smolt, so that at the present time we have about 80 million fish in the sea cages. This crop will reach harvesting size in late 1989 and early 1990, and should bring 1989 production to about 120,000 metric tons, and 1990 production to about 160,000 metric tons. In addition, we expect to harvest about 5,000 mt of large trout.

Problems

In the past two years, certain events have occurred that indicate continuing unrestricted expansion of the salmon farming industry is unlikely.

Disease. Intensive cultivation always increases the likelihood of disease, and new diseases were both feared and expected. In 1985 the first major disease to hit the industry was "Hitra disease," otherwise known as "coldwater vibriosis," caused by the bacterium *Vibrio salmonicida*.

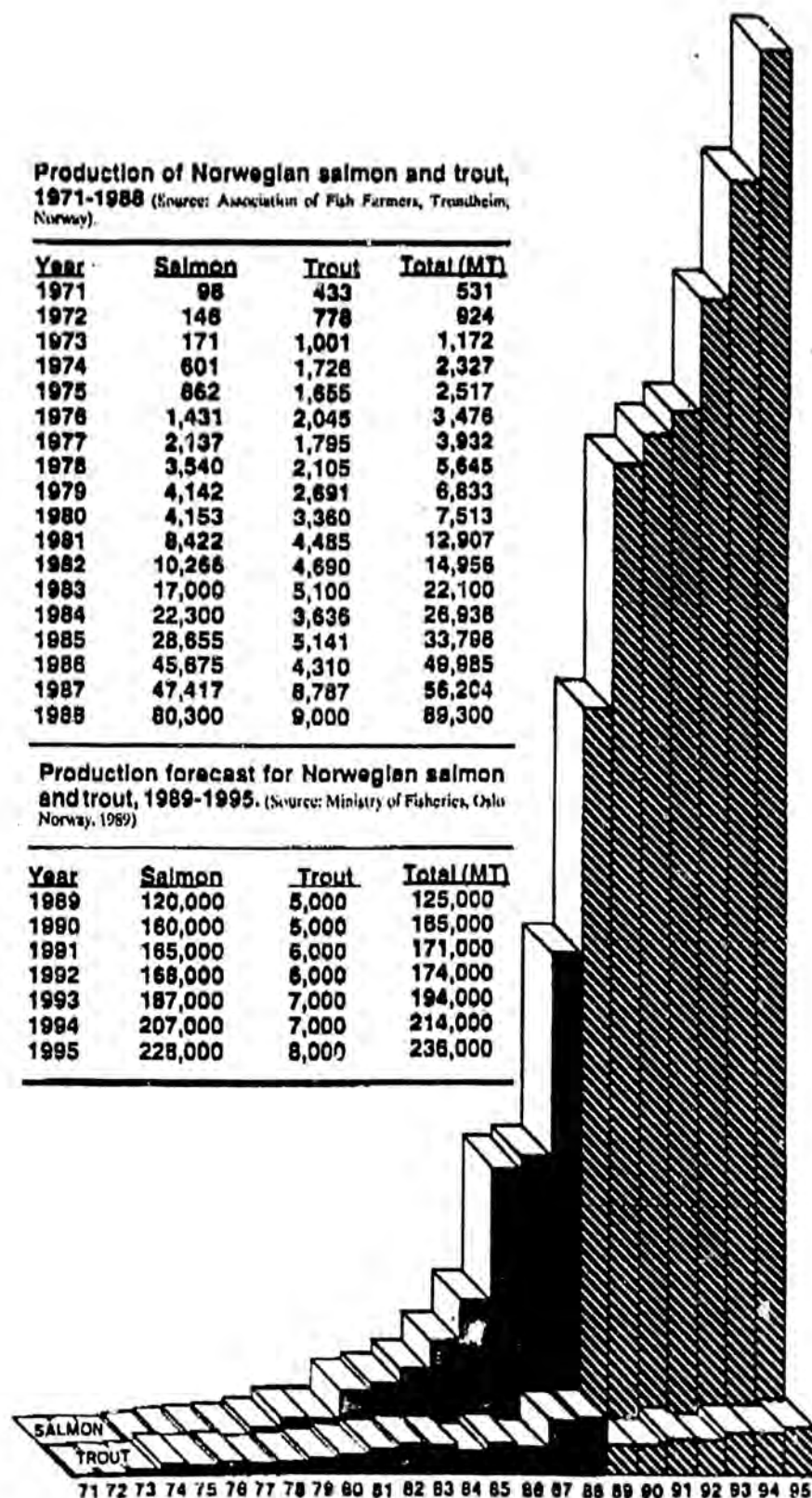
This disease forced some farmers to slaughter all their livestock just on suspicion of the disease. It also caused the premature marketing of perhaps 8,000-10,000 metric tons of relatively small salmon in 1986. This in turn reduced the 1987 production. Researchers have now developed a vaccine, and results so far are encouraging. In essence we feel that with proper farm management, Hitra disease can be controlled.

Production of Norwegian salmon and trout, 1971-1988 (Source: Association of Fish Farmers, Trondheim, Norway).

Year	Salmon	Trout	Total (MT)
1971	98	433	531
1972	148	778	924
1973	171	1,001	1,172
1974	601	1,728	2,327
1975	862	1,655	2,517
1976	1,431	2,045	3,476
1977	2,137	1,795	3,932
1978	3,540	2,105	5,645
1979	4,142	2,691	6,833
1980	4,153	3,380	7,513
1981	8,422	4,485	12,907
1982	10,266	4,690	14,956
1983	17,000	5,100	22,100
1984	22,300	3,636	26,936
1985	28,655	5,141	33,796
1986	45,875	4,310	49,985
1987	47,417	8,787	56,204
1988	80,300	9,000	89,300

Production forecast for Norwegian salmon and trout, 1989-1995. (Source: Ministry of Fisheries, Oslo Norway, 1989)

Year	Salmon	Trout	Total (MT)
1989	120,000	5,000	125,000
1990	160,000	5,000	165,000
1991	165,000	6,000	171,000
1992	168,000	6,000	174,000
1993	187,000	7,000	194,000
1994	207,000	7,000	214,000
1995	228,000	8,000	236,000



Continued on page 65

We have encountered other diseases as well. BKD, IPN, furunculosis and others. While they are all a serious threat to the industry, we believe that we are now able to manage the disease problem. In general, we have upgraded our awareness of disease, and we have upgraded the capability of the institutions that have been established to deal with disease.

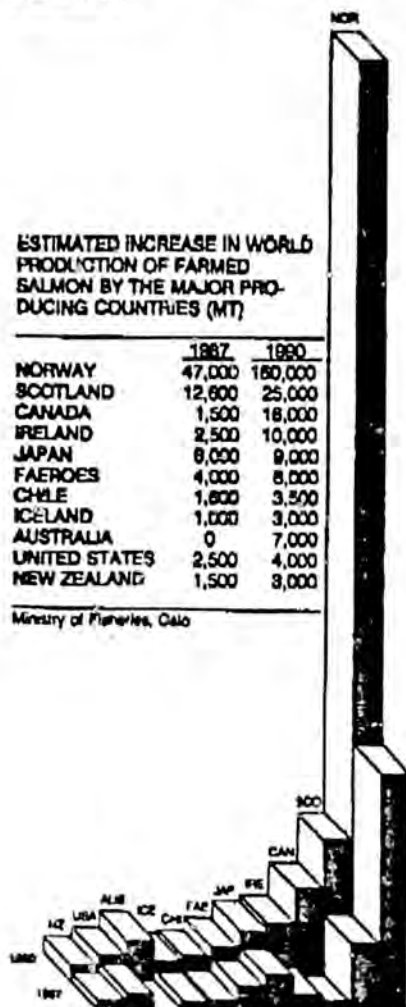
Health control on fish farms is under the jurisdiction of the Veterinarian General. The main strategy is to prevent the spread of communicable diseases through close monitoring of farms and strict enforcement of rules, particularly in relation to hatcheries. In spite of this, various diseases have occurred.

When an outbreak is noted, the farmers are required to contact the veterinarian authorities for permission to administer antibiotics. No fish treated with antibiotics may be harvested until nine weeks after treatment has ceased. This is to ensure that no antibiotics are passed on to the consumer.

ESTIMATED INCREASE IN WORLD PRODUCTION OF FARMED SALMON BY THE MAJOR PRODUCING COUNTRIES (MT)

	1987	1990
NORWAY	47,000	180,000
SCOTLAND	12,600	25,000
CANADA	1,500	18,000
IRELAND	2,500	10,000
JAPAN	9,000	9,000
FAEROES	4,000	8,000
CHILE	1,800	3,500
ICELAND	1,000	3,000
AUSTRALIA	0	7,000
UNITED STATES	2,500	4,000
NEW ZEALAND	1,500	3,000

Ministry of Fisheries, Oslo



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All our efforts so far have been directed at disease control, and only recently have we instituted programs for disease prevention. With the development of new vaccines, and with the incorporation of a disease prevention program we feel confident that disease problems will be controlled.

Environmental Problems. Last year, we experienced what many thought would be the ultimate catastrophe: a full fledged algal bloom in Skagerak and along our southern coast. But as soon as fish started dying, farmers started moving their pens away from the affected areas. Through a superb effort by the salmon farmers' organization and the authorities, almost all the farms were saved. Only some 500 metric tons of salmon were lost, or about 0.6% of our total 1988 production.

However, this incident served as a warning that we must pay much closer attention to the marine environment. Partly as a consequence, the authorities and the salmon farmers' organization have established a round-the-clock surveillance and warning system, which warns about algae, oil spills etc. and also about changes in temperature, weather, and other factors which are important to the salmon farmer. The system is based on a complex network of buoys, satellites, and earth stations which monitor our area.

I would like to point out that it is not enough to be informed about these disasters when they develop. We must also try to prevent the pollution of our

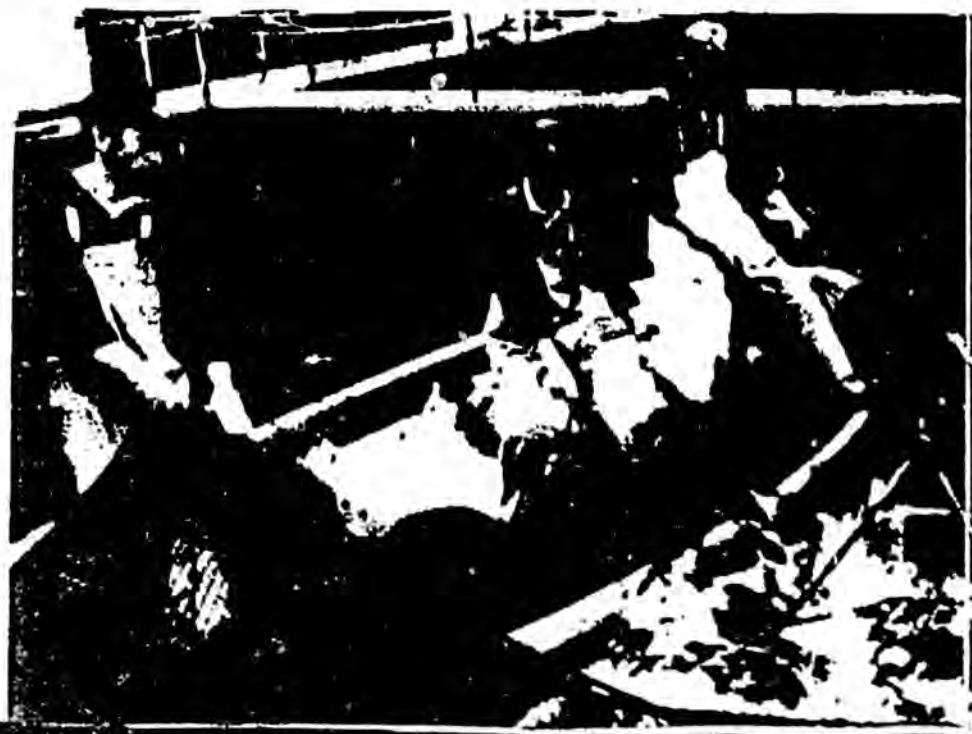
marine environment as well as our air and our soil.

Competition. We now see massive investments in the salmon farming industry in countries such as Scotland, Ireland, Iceland, the Faeroes, Canada, USA, Chile, Australia, and New Zealand. Others are sure to follow. As a curious example, a joint venture is now being set up in East Asia between a Norwegian company and the Soviet Union, on Soviet soil.

Norway is concerned about this competition. In Chile, production costs per kg are reportedly about \$0.50 below what they are in Norway, and transportation costs from Chile to the west coast of the United States are about equal to those from Norway to the U.S. East Coast. Canada is coming onstream now with high quality salmon, both Pacific and Atlantic, at production costs about the same as those in Norway, but with the U.S. market at its doorstep. So in the North American market, we see Norway being squeezed on both sides, to the south and to the North, and possibly losing market shares rapidly over the next two to five years. However, there is still room for considerable expansion in the North American market.

In Europe, Norway is still competitive with regard to quality and the costs of production and transporta-

The harvesting process combines hard physical labor (*below*) with mechanization (*facing page, top*) to move the fish rapidly from cage site to processing plant.





tion but we are facing serious challenges from within the Common Market. Producers in Scotland, Iceland, and the Faeroes are giving us a hard fight for the market, and I fear that our market shares will decline.

Market Saturation? In preparing this paper we searched in vain for authoritative figures on the future demand for farmed salmon. Perhaps most people in the industry feel that demand will be limited only by supply. We have attempted to estimate the market for farmed Atlantic salmon, and the figures are, I think, rather astounding. Still there are those who believe the market is even larger than we estimated (*see figure, overleaf*).

But an enormous increase in market demand will not come about by itself. A considerable effort both in terms of promotion and product development will be needed.

It should be pointed out that product development within the salmon industry has been practically non-exis-

tent. The salmon farming industry has supplied just a few simple products: fresh whole salmon, frozen whole salmon, and smoked salmon. The industry has had no need to come up with a more varied assortment, but we believe this will be necessary in the future, particularly to utilize more profitably the lower quality fish.

The future

Norwegian salmon farming will face a number of challenges in the future.

While we in Norway are relatively optimistic about the market prospects, we also realize that the worldwide increase in production and resulting competition will force prices down. To meet this challenge, we must improve the economic performance of our industry, the quality of our product, and our product development. To hold our own, we are planning to double our research and development efforts. In fact the

government contribution to research more than doubled between 1985 and 1989.

We expect that Norwegian salmon farming companies will enter into joint-venture operations in other countries. Indeed, some Norwegian companies have already started operations abroad. According to a survey taken at the beginning of 1987, Norwegian companies were involved in 72 foreign operations in 15 countries, and this number has increased since the survey was completed. Norwegian companies have been particularly active in Canada.

We also expect there will be developments in sea ranching, or as we call it, "culture-based fisheries." We know that the Japanese have been experimenting with salmon sea ranching for some time, and our good neighbors to the west, the Islanders, have also looked into it. Salmon sea ranching is still experimental, but we hope to



Great care is taken to ensure delivery of premium quality product, everything from the careful removal of small bones from a fillet (left) to the rapid processing and chilling of the harvested product before shipment. Salmon that meet the standards of superior quality are identified with a golden tag—the consumer's assurance of quality (facing page, top).

move into the commercial phase very soon.

New species

Norwegian scientists have for some time been working on species other than salmon and trout. By the early 1990s, we expect that production will take off, and by 1995, farmed fish will become an important factor in our international high quality markets, particularly in the fresh fish markets.

Among the species we are working with at the moment are cod, halibut, turbot, wolffish, Arctic charr, oyster, mussels, and scallop. By the end of 1988, 420 permits had been granted for production of species other than salmon and trout. For many of these species, difficulties in fry production has been the major obstacle to success.

The most promising new species is cod. This is also the species with which we are closest to commercial operation. In 1987, we produced roughly a million cod fry, from which about 500 metric tons of cod were expected by late 1988. However, some problems developed, and the 1988 production was not that high. By the mid-1990s we expect that our farmed cod production will be 10,000 - 20,000 mt. In other words, cod is becoming a major factor in the development of Norwegian aquaculture.

For the other species, it is too early to estimate production figures, but we expect that Arctic charr and turbot will become commercially viable very soon.

In summary, the Norwegian salmon farming industry has undergone explosive development, particularly in the last six to seven years. In 1988, about one-third of the value of our fish exports came from aquaculture and the shift from capture to culture fisheries is therefore very much a reality in Norway.

However, the Norwegian aquaculture industry is facing increasingly difficult times because of the expanding competition. We expect that as more producers enter the market, prices will decline. In fact, we saw the first signs of this in 1988. As a result the focus of the industry will shift to the economics of production.

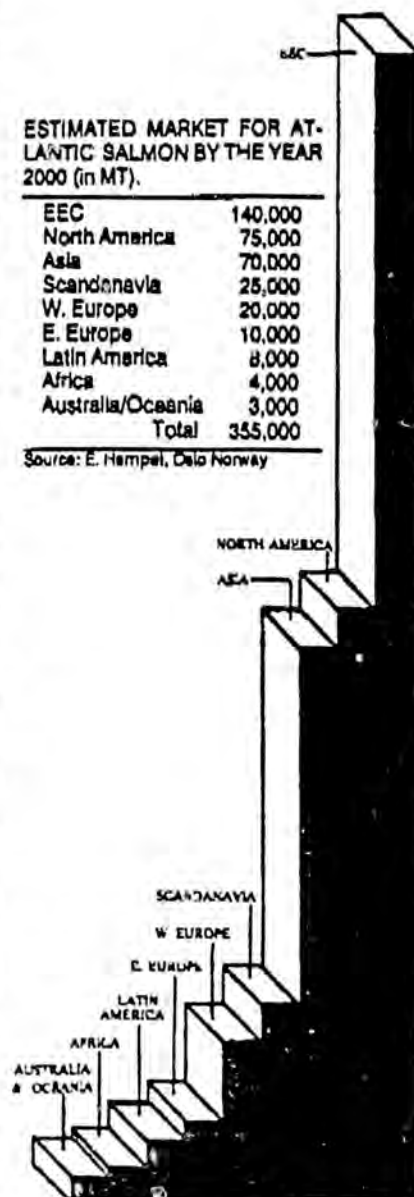
Health and environmental considerations will also play an increasingly important role in the industry's development. Soon we will have to have to be more concerned with margins that originate from efficiency of operation. When this happens, we expect the Norwegian industry to fall behind its competitors, because of the structure of our industry. We also expect that farming companies will want to establish operations in other countries to achieve the necessary economies of scale, proximity to market, and lower production costs.

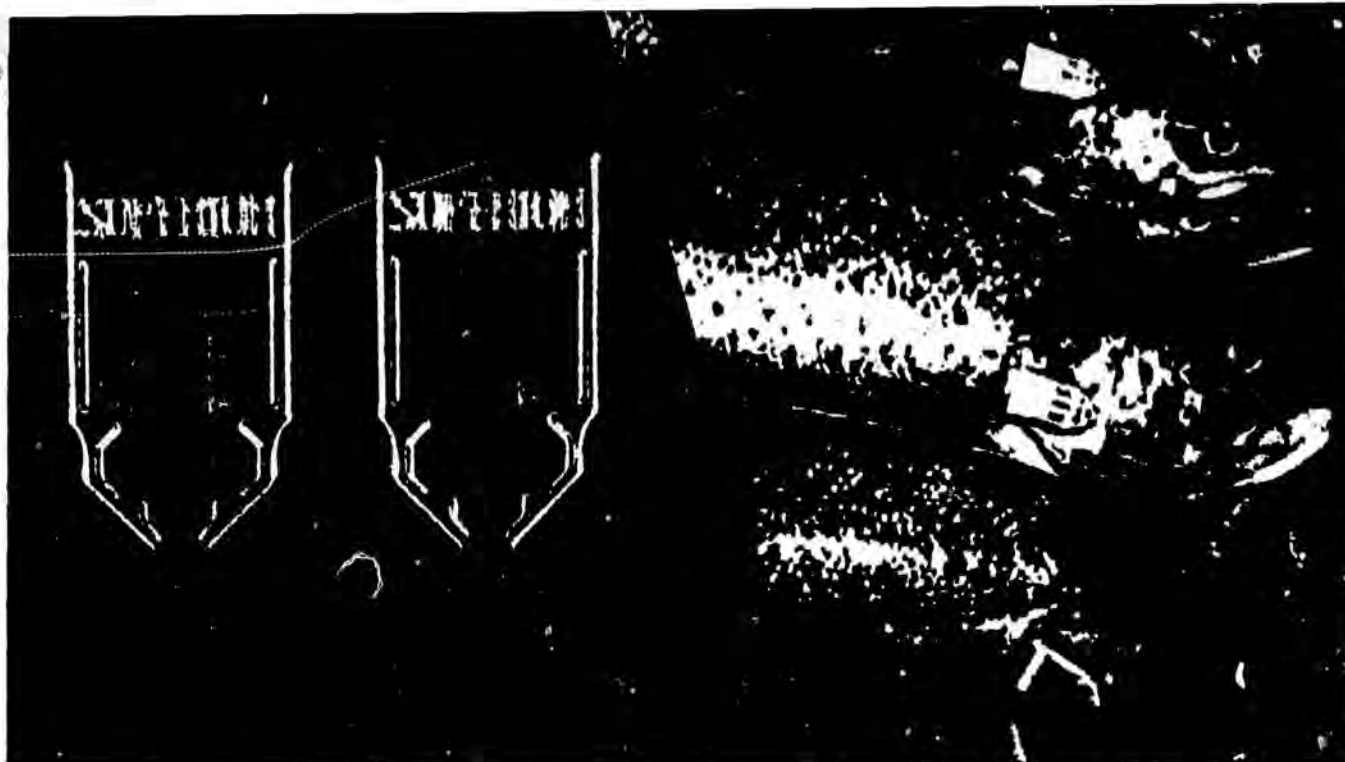
Problems such as disease and pollution have already affected the Norwegian industry, and may continue to do so. As the industry develops, and requires greater emphasis on good management, we will see problems of another nature emerge. So far, the economics of Norwegian salmon farming have been good, but we do

ESTIMATED MARKET FOR ATLANTIC SALMON BY THE YEAR 2000 (in MT).

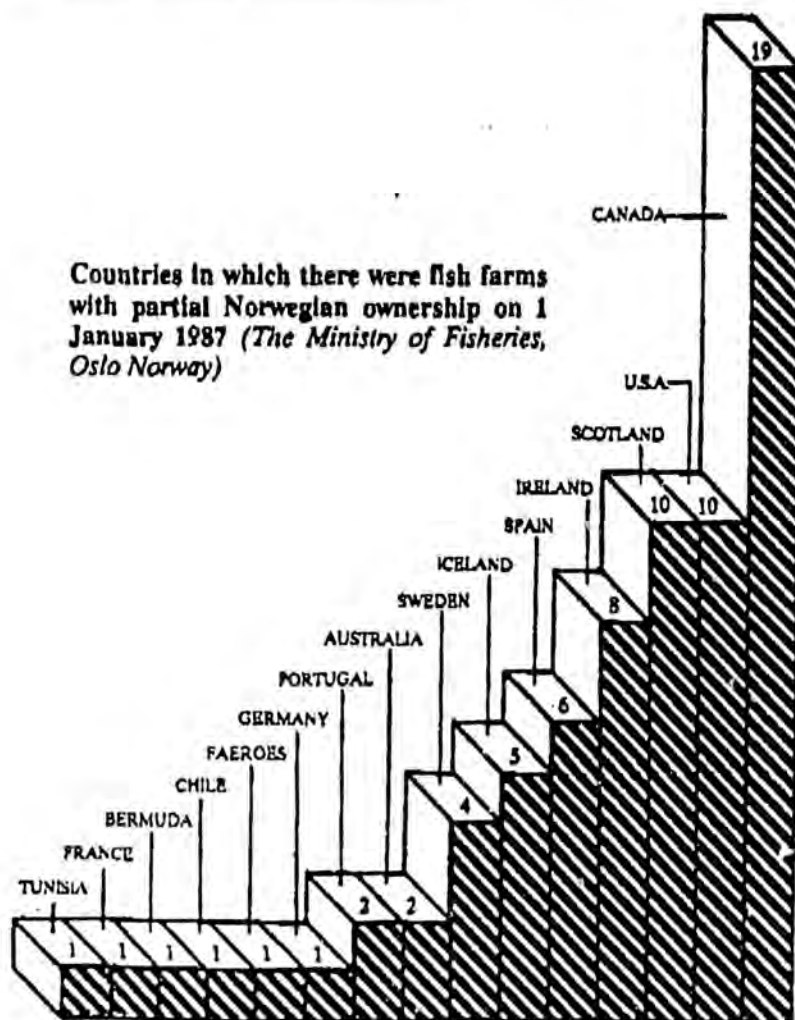
EEC	140,000
North America	75,000
Asia	70,000
Scandinavia	25,000
W. Europe	20,000
E. Europe	10,000
Latin America	8,000
Africa	4,000
Australia/Oceania	3,000
Total	355,000

Source: E. Hempel, Oslo Norway





Countries in which there were fish farms with partial Norwegian ownership on 1 January 1987 (*The Ministry of Fisheries, Oslo Norway*)



expect that harder times will force a restructuring of the industry, and the adoption of alternate methods of farming, such as land or sea-based closed systems. Norway has developed the technology for this on a large scale, and we expect to see the results of this soon.

Finally, we hope that Norway will continue to be among the leaders in the farming of such new species as cod, turbot, Arctic charr, halibut and lobster.

We have a deep belief in aquaculture as a future growth industry. I personally believe that it will, over the decades, become a substantial supplement to our traditional fishing industry as a source of animal protein. We see this as a natural development of the fisheries industry as we move from capture to cultivation. •

Blarne Mark Eidem is the Minister of Fisheries for Norway. This article is a distillation of his keynote address at the opening session of Aquaculture '89 in Los Angeles California, February 1989.

**Recycling the
land to keep pace
with our passion
for seafood**



FISH



**by Donna
Florio**

Inhabitants of Atlantis would understand aquaculture. Farming the sea or redesigning cotton, tobacco and rice fields to grow fish is a concept people of that watery domain could easily embrace, but one that takes some rumination on the part of land-bound humans. After all, we are accustomed to growing vegetables—not fish—in the ground.

But take a moment for deliberation. Land animals—chickens, cows and pigs—are grown for their food value, fed and nurtured until they're the perfect size for slaughtering, or until the price is right. Fish and shellfish, on the other hand, are wild creatures, available for harvest only when the time, tides and whims of nature are right. But our ever-increasing taste for them is forcing processors to look for new seafood sources, and aquaculture appears to be a practical choice. So practical, in fact, that a small army of American aquafarmers has sprung up in the past two decades, producing everything from salmon to oysters to catfish, in an attempt to satisfy our hunger for heart-healthy seafood.

Aquaculture is the production of aquatic plants or animals—fish, shellfish and amphibians—in a controlled environment for all or part of their life cycles. For example, fish that are normally found in freshwater rivers and lakes, like striped bass, tilapia (a warm-water fish native to Africa) and catfish, are reared in man-made earthen ponds or even cement

tanks (often called raceways) filled with clean well water. There they are fed, protected from disease and easily harvested. Although the term "aquaculture" is used to describe both freshwater and saltwater farming, the latter is sometimes called "mariculture"—aquaculture with a grain of salt, so to speak.

The practice of freshwater fish farming dates back 3,000 years to China, where carp were—and are—grown in ponds as a major protein source. The tradition is so strongly entrenched throughout Asia that Eastern countries contributed 84 percent of the world's aquacultural production in 1985.

There are other forms of aquaculture as well. Bivalve shellfish (clams and oysters) are grown under less controlled conditions than are freshwater fish. Tiny baby clams and oysters, known as larvae, are coaxed to "sit" or attach themselves to shells that are placed in appropriate intertidal zones to mature. The shellfish aren't fed special food; rather, they dine on algae—microscopic plants—found in the water. Saltwater fish like salmon are grown in small net pens that float in open bodies of salt water. Shrimp are grown in saltwater ponds.

A Fish Story

Unlike the rest of the world, the United States was slow to initiate fish farming. The seemingly limitless supply of natural resources, high start-up expenses for farms and the lack of proven technology tempered interest in the concept until the '60s.

Now there are aquafarms scattered throughout America. The bulk are catfish farms in the South, primarily Mississippi, but there are trout farms in Idaho as well as salmon and shellfish farms in Maine, Oregon and Washington—and business is booming. Aquaculture is the fastest-growing segment of the agriculture industry, averaging a 20 percent growth rate in the '80s. The U.S. Department of Agriculture (USDA) estimates that 700 million pounds—nearly \$550 million worth—of cultured seafood were harvested stateside in 1987. Catfish, salmon and rainbow trout are far and away the market leaders, followed by hybrid striped bass, redbass, mussels, clams, oysters, crawfish, shrimp and even alligators.

"Some farmers weren't doing well with traditional crops and were looking for alternatives. They found aquaculture," explains Dave Harvey, a USDA economist specializing in aquaculture. While commercial wild-harvest fisheries have room for expansion, it's mostly in species Americans don't eat, like menhaden, which is used for pet food and fish meal. Fishing

How Farmed Fish Shape Up

PRODUCT	SPECIES	CALORIES	FAT	CHOLESTEROL	OMEGA-3
Catfish	Channel	128	6.9 g.	33 mg.	0.1 g.
Salmon	Atlantic Coho	129	5.6 g.	35 mg.	1.4 g.
		150	6.6 g. (varies)	39 mg.	0.8 g.
Trout	Rainbow	131	5.8 g.	56 mg.	1.1 g.
Crawfish (Crayfish)	Red Swamp; White River	80	0.8 g.	90 mg.	Not available
Shrimp	White	90	8.0 g.	96 mg.	0.34 g.
Oysters	Japanese	90	2.2 g.	47 mg.	0.71 g.
Mussels	Atlantic	89	2.2 g.	28 mg.	0.43 g.

(All figures for 3½-ounce, uncooked portion)

en in the United States was the product of aquaculture. And for some species, the percentage is far higher—all the rainbow trout, catfish and hybrid bass served in restaurants or sold in markets are farmed. A high percentage of the shrimp we eat is imported, much of it cultured in countries like China, Ecuador, Indonesia, Mexico and Taiwan. Although farmed fish and shellfish cost more to produce than wild fish—ponds, food, equipment and staff are expensive—these products often offer more consistent availability, quality and, some would argue, safety and taste.

The Catfish Craze

Among American-bred seafoods, catfish is the runaway success story. The species's mild white flesh, wide availability and reasonable price, along with aggressive marketing by major producers, have given status to a lowly "trash" fish, once eaten only by poor people in the rural South. Catfish is sold throughout the United States, in the Orient and in Western Europe, and is so popular that production jumped from under 10 million pounds to 280 million pounds in less than 10 years.

But the South is still home to the catfish; 80 percent of growers hail from Mississippi, with the remaining 20 percent scattered throughout Alabama, Louisiana, Texas and other states in the region. One up-and-coming farm, Carolina Classics Catfish, is in Ayden, North Carolina, a small town located between Greenville and Kinston.

On an icy day last winter, I drove there to see what all the excitement was about. I found a modest, modern processing plant, some former tobacco fields

A smorgasbord of aquaculture, opposite page. From top to bottom: far left, blue mussels, hard clams; center, channel catfish, rainbow trout, hybrid striped bass, tilapia, red tilapia; right, Pemaquid oysters, white shrimp, Blue Point oysters.

spawned an aquaculture revolution

for the species people do eat is often restricted or banned due to overfishing or contamination by PCBs (polychlorinated biphenyls). Yet the National Fisheries Institute reports that seafood consumption is increasing: Americans ate 15.4 pounds of fish per person in 1987, up from 12.8 pounds in 1980, meaning that the seafood industry needs to produce an additional 640 million pounds of seafood annually.

In 1988 an estimate of 10 percent of all seafood eaten in the United States was produced in aquaculture.

Above: Harvesting farmed Atlantic salmon at Ocean Products in Eastport, Maine. Gentle handling of fish during harvest minimizes the possibility of bruised meat. **Below:** Employees at a Mississippi processing plant load cleaned catfish onto a conveyor belt for passage through a quick-freezing machine, the final step in the market-preparation process. As an alternative to freezing, some companies ship fresh catfish packed in ice.



converted to fish ponds and a young, savvy company president, Rob Mayo, who is an anomaly among area farmers. His farm, founded in 1986, is smack dab in the middle of Pitt County, "the largest flue-cured-tobacco-growing county in the free world."

From 20 acres of ponds, Carolina Catfish Classics has grown to several hundred acres and a full-scale processing plant. Although the former oil-industry engineer won't disclose current production figures, Mayo says the company's short-term goals are to harvest and process a thousand acres of ponds, or roughly one million pounds of fish. That, says Mike McCall, editor of *The Catfish Journal*, is large, even by Mississippi standards. "The average size of a Mississippi fish farm is 255 acres," he says.

To start a catfish farm, you need flat land in which to dig ponds; good, clay-based soil; and an abundant, clean supply of fresh water. Most of all, you need money. Start-up costs average \$2,000 to \$3,000 per acre for a 300-acre farm. It takes 16 to 18 months for a two-inch fingerling to grow to a foot-long, one-and-a-half-pound catfish ready for harvest. During that time, a grower not only has to pay interest on his capital investment, but he also needs a steady flow of operating cash for the first two years. And, as with land farmers, aquaculturists are vulnerable to the whims of nature. In warm weather, for instance, algae can die in a pond overnight and deplete the oxygen supply, killing the fish.

Such uncertainty is one of aquaculture's strongest drawbacks. Because the industry is so new, it's difficult for interested farmers to get financing. "The easiest part is selling the fish," says Mayo. Thus far, the industry's rapid growth has attracted cash-rich megacorporations; Hormel and ConAgra now have operations in Mississippi. But most farmers have more modest backers—if any.

Such matters mean little to a catfish. Those farms that don't have on-site hatcheries where fish eggs are fertilized and nurtured until ready for the pond

purchase fish as fingerlings, two to eight inches long. Some farmers prefer smaller fish, which take longer to grow but cost less than larger fingerlings. Though expensive, bigger fish are stronger and reach full size more quickly. Mayo's ponds—roughly 12 acres each—are home to up to 70,000 fingerlings at a time.

As at other farms, the water in Mayo's ponds is monitored to be sure the fish receive sufficient oxygen and to control levels of ammonia or nitrates from their bodily wastes. To ensure a steady supply of oxygen, crews check the ponds regularly, often several times a night in hot weather. If the oxygen level dips, aerators are used to bubble more air into the water.

Twice a day in the summer, once daily in the winter, the fish are fed with the help of a tractor-pulled machine that blows food pellets across each pond's surface. The pellets are designed to float—both to keep the fish from dining on the pond's bottom and to allow observation of the fish. If appetites seem poor, a staff member checks the fish for disease and, if necessary, treats them. The fish are also routinely sampled for contaminants and fed vitamin C.

Those fish that survive the 18 months of tender loving care from egg to harvest size are scooped up in huge nets designed to let smaller fish escape and transported live to a processing facility. A few are

A lifetime of regularly eating seafood

sacrificed for a taster who microwaves and samples pieces of tail meat. If the fish taste "off"—flavor can be influenced by algae and the earth from which ponds are made—it's back to a clean, freshwater pond for a few days to improve flavor.

Once fish pass muster, they're unloaded into aerated concrete troughs. Eventually they're conveyed into the plant, electrically stunned, headed with a band saw, gutted, skinned, chilled and sized. Some are shipped as is—the term is "dressed." Others are processed into steaks, fillets, fingers or nuggets. Part of the harvest will be frozen for buyers; the rest will be boxed and shipped fresh. Total elapsed time from pond to shipping is less than 12 hours.

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Down the Hatch

What catfish eat is as important as how much. Exact formulas vary, but they're similar to diets of other farmed fish. The basic pellet mixture consists of 50 percent to 55 percent soybean meal, 25 percent to 35 percent corn and 15 percent to 25 percent other nutrients, including a fair portion of fish meal, which is the "chief gustatory ingredient," according to Mayo.

The percentage of fish meal is actually quite small, although raising it may increase the amount of omega-3's (see "How Farmed Fish Shape Up," page 73) found in farmed fish, particularly salmon and trout, and produce a stronger "fishy" flavor, says Joyce Nettleton, author of *Seafood and Health* (Osprey Books, 1987) and director of a recent study of farmed catfish by The Catfish Institute.

While the daily diet of farmed catfish may not sound exciting, it is reasonably clean and extremely efficient. It takes 1.4 to 1.8 pounds of food to raise a fingerling to the one-and-a-half-pound market size, compared to eight pounds of feed for a pound of beef or three pounds for a pound of chicken. Chickens are also fed small, regular doses of antibiotics, to which bacteria can become resistant. And that can pose problems to both sick chickens and the humans who eat them. Though cultured fish develop parasitic, bacterial and viral diseases just like dogs, cats and

A Mackerel a Day...

Medical studies around the world have presented evidence that a lifetime of eating fish and shellfish three or more times a week may lower the incidence of heart disease, help stave off some types of cancer and lessen the severity of inflammatory diseases like rheumatoid arthritis. "All these effects have been shown in experimental animals and sometimes in humans," says Dr. William E. Connor.

Omega-3's are very long-chained fatty acids found in small quantities in certain vegetable oils and in larger amounts in fish oils. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are thought to be the two components that may trigger heart-protecting mechanisms. Since omega-3's are concentrated in fish oils, generally the fattier the fish, the bigger the dose you'll get.

Studies by Connor have shown that triglyceride levels dropped significantly when patients ate plenty of salmon and eliminated all other fat from their diets. Very low-density lipoproteins (VLDL, one of the "bad" cholesterol) also decreased. Levels of HDL (high-density lipoprotein, the "good" cholesterol) and LDL (low-density lipoprotein) remained about the same. According to Connor, a high-omega-3 diet increases cholesterol excretion from the body and sometimes decreases the production of LDL. Research also indicates that EPAs may reduce the ability of platelets to stick together in the blood, thus preventing heart-attack-causing clots.

Joyce Nettleton recommends

that people obtain their omega-3's from fish rather than fish-oil capsules. "In addition to providing omega-3's, the fish will substitute for other food that may be worse for you, such as fatty steaks or cheese. That will do something for you that no capsule can." And she points out that capsules not only vary in the amount of EPA they contain, but also that they add more fat to the diet, an unsound nutritional practice.

"People should get their nutrition from food whenever possible," concurs Connor. Capsule use is acceptable in certain instances, he says—when a person is allergic to seafood, for example, or is ordered by a doctor to use capsules to help lower high blood triglyceride levels.

To get optimum results from your seafood, experts advise the following: ■ Eat a variety of fish, lean and fat. Of the farmed species, fattier fish like salmon, sardines and rainbow trout offer the most concentrated sources of omega-3's. Wild salmon, mackerel, herring, mullet and tuna also have high oil contents. But leaner fish such as cod also are excellent sources of omega-3's. ■ Replace other sources of animal protein with fish and shellfish like oysters, scallops and clams. But don't expect fish to be a panacea. Your general diet should be weighted in the direction of lower fat and cholesterol. ■ Don't sabotage your diet by frying fish or larding on rich sauces. Instead, opt for baking, broiling, stir-frying or poaching, and use low-fat toppings.

may prevent heart disease

humans, says John Plumb, professor of fisheries and aquaculture at Auburn University in Alabama, they're likely to be treated with antibiotics or other therapeutic substances only when ill.

In some instances, medication isn't the answer. At press time, the first North American outbreak of an untreatable fish virus—viral hemorrhagic septicemia (VHS)—inexplicably occurred in two wild salmon hatcheries in the Pacific Northwest. VHS is prevalent in wild and farmed European fish, especially salmon, and is spread through fish urine and feces, so cultured fish in ocean pens can contract it. While not harmful to salmon or humans, it is fatal to some species of sport fish, such as rainbow trout and steel-

head. Washington officials killed millions of fish eggs and young fish in an effort to halt the disease and were planning to examine marine life in rivers to determine how widespread the virus is.

How Pure?

Close attention to quality control has gained farmed fish a strong reputation in the marketplace. For example, processors routinely monitor waste for contaminants and boast that their products are far cleaner than many species of wild-harvest fish. Also, catfish, like trout, tilapia and hybrid bass, are usually grown in drinking water from regional aquifers or deep-water wells. This makes them less likely to encounter pollutants that may be found in the reservoirs, rivers and streams where their wild cousins live. In inspections of catfish as they arrived for processing, "we found no significant levels of the pesticides the Food and Drug Administration [FDA] regularly looks at, and PCBs were well below the allowable levels," says Dr. A.M. Guarino, chief of the Fishery Research Branch at the FDA's Dauphin Island, Alabama, facility. The Catfish Institute study, in fact, concluded that catfish "pose no measurable risk to human health" from PCBs, heavy metals or chlorinated hydrocarbon residues.

Logically, Guarino says, "We would have expected more indication of pesticides in catfish samples. Many of these fish farms are former cotton farms, so there should be lots of hard pesticides in the ground—that's the logic—but there aren't."

One theory holds that most of the pesticides have been washed down into the groundwater. Ponds are built above the water table, and the tightness of the soil apparently prevents any remaining chemicals from tainting the water. Tony Mazzaccaro, aquaculture specialist for the USDA, speculates that pesticides are probably not a problem for diners because they're so deadly to the fish. Still, fish farmers are asked not to build ponds over a "hot spot"—the area where the farm's pesticide tank was filled—because the soil can contain pesticide buildups.

The relative lack of contaminants in farmed fish is a selling point marketers are touting even more vigorously in the wake of concern about the condition of the oceans and pollution's toll on seafood. "We know where our fish's mouths have been and what they've eaten," says Mayo. "And they're raised in well water that is free of agricultural contaminants."

While this holds true for cultured products raised in fresh water, those fish that spend all or part of their lives in salt water, depending on the location of the pens, may be exposed to the same contaminants, diseases and parasites as their cousins who live in the wild. Salmon, however, are routinely vaccinated at the hatchery against prevalent bacterial diseases and, because their diets are controlled, rarely consume common parasites that can be transmitted to humans. But oysters, clams and mussels are partially raised in near-shore waters that may contain pollutants from municipal and industrial waste plants, as well as runoff from farms and city streets. Shrimp ponds are generally filled with water from such estu-



aries. However, aquaculturists try to choose unpolluted farm sites.

In spite of the potential problems of wild stock and saltwater-cultured seafoods, cases of illnesses related to them are low. From 1978 through 1984, the Centers for Disease Control received reports of only 5,080 such cases—a mere 5 percent of food-borne illnesses. Most of these resulted from people eating raw oysters and clams; the others, from fish contaminated with the naturally produced poisons, ciguatera toxin and scombrototoxin.

"Generally, most fish in the marketplace—wild and farmed—are safe," says Nettleton, who has been at the forefront of research on the nutritional safety of seafood. "But some species of wild fish, particularly if they're older and larger, may concentrate pollutants." Bottom-feeders such as croaker and red drum generally dine on creatures that burrow in the mud,

The Salmon in Grateda burrows from traditional Italian cuisine. After basking in a lemon-and-olive-oil marinade, salmon fillets are dipped into a fennel-and-bread-crumble mixture, then gently sautéed. Chef Joyce Goldstein of Square One Restaurant in San Francisco serves her version with sautéed Swiss chard or spinach and sliced lemon. For this recipe and others, see page 94.

To some chefs, farmed fish are superior

where heavy metals settle in polluted areas. "Worms, little snails and crustaceans pick up small amounts of contaminants from the sediment and the larger fish eat them," explains Nettleton. "During the digestive process, these can enter the fish."

But John B. Pearce, deputy director for research
(Continued on page 89)

FIELDS OF FISH

(Continued from page 76)

and science of the National Oceanographic and Atmospheric Laboratory in Wood's Hole, Massachusetts, says there have been few, if any, documented cases of death in the United States or Europe due to ingesting toxic trace metals found in fish, because the amount of such metals is so minute. As part of a team of scientists working on the United Nations' second report on the world's oceans, he says that researchers today "don't see toxic trace metals as a major environmental problem." Such metals could affect the reproductive capabilities of fish, but that's another issue. "The real impact of all this is on the seafood itself, not on the people who eat it," he says. "There is concern about future increases and how that might affect marine life or seafood."

Outweighing the uncertain potential for illness are the health benefits of eating fish and shellfish. Dr. William E. Connor, director of endocrinology, metabolism and nutrition at Oregon Health Sciences University in Portland and coauthor of *The New American Diet* (Simon & Schuster, 1986), is a proponent of seafood in the diet. "Fish and even some shellfish have a low cholesterol and saturated fat index," he says. "They are good sources of calcium and protein. But the more positive benefit is the inclusion of omega-3's, as they may lessen the incidence of coronary heart disease when consumed over a lifetime."

So where does this leave the fish-loving consumer? Obviously, aquaculturists believe their products are superior. Aquatic Systems, Inc., of San Diego, produces hybrid striped bass in circular concrete tanks filled with artesian geothermal groundwater. Not only are those fish not exposed to as many potentially pathogenic viruses, bacteria or contaminants saltwater or wild species contend with, they have a much lower incidence of parasites. Trout farmers in Idaho and North Carolina also claim to use clean aquifer water. And some crawfish are pond-raised, giving them the same advantages as trout, catfish and bass.

But consider that in Tokyo, the Japanese pay up to 100 percent more for a high-quality wild fish than a cultured fish. According to Richard Lord, information officer for New York's Fulton Fish Market, the aesthetics of the fish—color, firmness and a good "figure"—are very important to these most sophisticated of all seafood consumers. To them, farmed fish are soft and lazy. In this country, too, soft texture and bland flavor have been the main targets of aquaculture critics.

As a seafood consumer, you are the final arbiter, and the best decision is an informed one. Go to the seafood market. Inspect the varieties of fish, ask which products are farmed or wild, and choose one whose appearance and price appeals to you. For the next few nights, return, and choose something different each time. Cultured fish—salmon, catfish, hybrid bass and trout—will surely be in the refrigerator case, along with shrimp (perhaps from Ecuador) and maybe crawfish, tilapia and carp. Before long, you'll understand the differences among the various wild and cultured species enough to make your selections confidently, and you'll be varying your choices enough to make mealtime interesting. The people of Atlantis would approve. [H]

DONNA FLORIO is a seafood specialist and freelance writer living in Charleston, South Carolina.

PHOTOGRAPHS OF FISH FOR PHOTO ON PAGE 72: CHANNEL CATFISH FROM CATFISH FARMERS OF AMERICA; RAINBOW TROUT FROM CLEAR SPRINGS TROUT COMPANY; OYSTERS AND BLUE MUSSELS FROM GREAT EASTERN MUSSEL FARM, INC.; HYBRID STRIPED BASS AND HATCH CLAMS FROM SOUTH CAROLINA MARINE RESOURCES; DEPARTMENT OF AGRICULTURE; TILAPIA FROM ANNEBORO MOUNTAIN AQUACULTURE.



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From Ketchikan to Barrow.

While Alaskans continue the debate over salmon farming, other forms of aquaculture are flourishing in the state.

Take Don Nicholson's oyster farm in Coffman Cove, on Prince of Wales Island in southeastern Alaska, for example.

Each year since 1985, Nicholson and partner Annie Caldwell have raised 100,000 plump, juicy oysters for up-scale restaurants in Anchorage and Washington. And although the fresh oysters are shipped via costly floatplane and commercial jetliner, Nicholson and Caldwell manage to stay competitive in the marketplace.

"Our prices are a little higher than those from the Lower 48," said Nicholson, co-owner of Canoe Lagoon Oyster Co., "but we have a high-quality product that's grown in pure Alaska waters, and we are able to maintain a consistent supply for our customers."

Entrepreneurs throughout Alaska are starting to successfully har-



Ralph Bache reels in a lantern net containing several hundred oysters destined for restaurants in Alaska and Washington. (John Church/Alaska Sea Grant College Program)

vest mussels, clams, scallops, abalone and seaweed.

There are about 40 licensed aquaculture farms in the state, raising mostly oysters and mussels, according to Janet Burleson, resource manager with the Alaska Department of Natural Resources in Juneau. That number is up from only 10 three years ago.

"We believe the aquaculture potential in Alaska is enormous," said Roger Painter, executive director of the 200-member Alaska Mariculture Association. "It may take us a while to get there, but eventually aquaculture will be a major industry in Alaska."

One stumbling block for newcomers to the aquaculture industry is the numerous regulatory hurdles that Painter said are partly the blame of commercial fishing interests worried about competition.

"We have a billion-dollar fishing industry that has proven thus far to be more viable," said Eric King, spokesman for the Alaska Trollers Association. ○

Federal Express buys Tiger International



Four Flying Tigers cargo jets line up at Anchorage International Airport, while a Federal Express truck drives by. A merger of the two companies will boost Alaska's economy. (Walt Johnson)

Federal Express announced in December the \$880 million purchase of Tiger International Inc., the parent company of Flying Tigers Line, one of the world's largest cargo airlines.

As many as 400 new jobs may be added to Flying Tigers' Anchorage operation.

Industry observers say the buyout signals that Federal Express will accelerate plans to make Anchorage a

hub for overseas deliveries, particularly to Japan.

"I would guess in the course of five years there might be well over a thousand jobs (in Anchorage)," Scott Hawkins told the *Anchorage Daily News*.

Hawkins is president of the Anchorage Economic Development Corp., a primarily public-funded agency that has a contract to build a \$10 million Federal Express facility in Anchorage and to create 700 new jobs in 1990. ○

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Additives to the Environment of Net-Pen Reared Fish
Pacific Marine Fisheries Commission 42nd Annual Meeting
Seattle, Washington, October 16-18, 1989

PH D Arthur H. Whiteley and Annamarie Johnstone

We have been asked to address our remarks to the matter of additives to the environment of net-pen reared fish. In this particular forum, we assume the emphasis should be on additives that may have an impact on humans when these fish come to market, rather than the impact on the plant and animal communities in the natural environment, though these are not wholly separable.

By its very nature, net-pen rearing of salmon requires the use of numerous chemicals, sometimes in large amounts, some used in the fresh water hatcheries to produce the fry and smolts, some used in the grow-out period in the marine pens, and others used during processing of the fish for the market. Partial lists are shown in Table 1, compiled from Austin and Austin, 1987, from a 1988 report for the Nature Conservancy Council by the University of Stirling, and from other sources.

The lists include chemicals used in salmon and in other forms of fish culture, both in this country and in foreign countries. Inasmuch as farmed fish are imported from some of these other countries, inclusion of these chemicals in the lists may be relevant to the matter of seafood surveillance in the United States marketplace.

Chemotherapeutics. The most relevant additives for present purposes are antibiotics and therapeutants used to control bacterial diseases. Because of stress, disease may cause losses of 30-40%, sometimes higher. Diseases in salmon farms include *Vibrio anguillarum* (vibriosis), *Aeromonas salmonicida* (furunculosis), *Aeromonas hydrophila* (hemorrhagic septicemia), *Yersenia ruckeri* (red mouth), *Vibrio salmonicida* (Hitra disease), *Renibacterium salmonarum* (bacterial kidney disease). To combat these diseases, medicated food containing antibiotics is supplied. In Washington, the FDA approved antibiotics and therapeutants are oxytetracycline (OTC), Romet 30 (sulfadimethoxine and orhomprim) and sulfamerazine. In addition, Tribissen (sulfadiazine and trimethoprim) is used in Norway and Scotland, and in British Columbia erythromycin is used to control BKD. In Japanese fish culture a wide variety of antibiotics has been used, but has recently restricted the use of chemotherapeutics in cultured fish (Aoki, 1988, pers. comm).

In the US, Norway, BC and Scotland, doses of drugs are as indicated in Table 1B. It is anecdotal, however, that additional amounts of antibiotics are used by farmers, who may mix the drugs with feed and binders. Control of use of antibiotics in Norway and Scotland is regulated by veterinarians, and this is supposed to be the case in B.C. In the British Isles it is apparently easy to find legal loopholes to permit other antibiotics and doses to be used (Austin and Austin, 1987). In Washington fish farmers are supposed to notify the Department of Fisheries if they use antibiotics, but veterinarian supervision is not required. Generally approval exists for only therapeutic use of these

drugs. Nonetheless they often are used prophylactically inasmuch as sick fish may not take the medicated food.

There appears to be no medical or public health supervision or regulation here, or in the other fish farming countries, on the use of antibiotics and chemotherapeutics other than the requirement of FDA approval of the three drugs and their dosages. There appears to be no monitoring by agencies of the use of these drugs or their persistence in marketed fish.

The amounts of drugs used are enormous. In Norway last year, 48 metric tons (105,000 lbs) of OTC alone were used - more than in animal husbandry and human health uses combined (Mehli, 1988, pers. comm. and press accounts). This figure has grown from 13,691 lbs in 1984 (Midtlying, 1985). The 1984 figure for Tribissen, nitrofurazolidon and sulfamerazine is 30,204 lbs (Midtlying, 1985). Comparable figures for British Columbia and Washington are not at hand. Assuming the dosages cited earlier for the 13 Washington pens, calculation leads to a first approximation of about one ton of OTC, a figure similar to that given by a Washington fish pen operator (Dr. A. Bill, 1989, pers. comm.).

The relevant issue here is "Do these uses affect man?" Consumers clearly would be exposed to residual antibiotics in the fish meat. Because of the potential for these residues producing a serious problem in public health, Japan has recently restricted the use of chemotherapeutics, and does not allow cultured fish to move to market if residual drugs can be detected in fish meat (Aoki, 1988, pers. comm.). The potential for adverse effects has been emphasized by Austin (1988, conference in Vancouver, B.C.; Austin and Austin, 1987). The current regulations for control of such residues are based on admittedly minimal research. The FDA requires a 21 day withdrawal period after the last medicated feeding of OTC and 42 days for Romet 30 before slaughtering for the market. In B.C. the withdrawal period is 42 days, and in Norway 61 days. Very few data exist for measurement of persistence of these drugs in fish flesh after feeding. McCracken et al (1976) measured the presence of trimethoprim in trout muscle 77 days after medication; Salte and Liestøl (1983) calculated that the withholding period for trout receiving OTC should be 100 days at winter temperatures, and for Romet 30 they recommended withdrawal periods of 60 days, above 10°C. All authors emphasize that temperature is a seriously complicating factor - residues of Romet 30 persisted for several months in fish at colder temperatures, leading Salte and Liestøl to recommend using the component drugs only in summer. Clearly these limited data do not support the FDA regulation of 21 days. New, more refined measurements of drug residues in salmon coming to market clearly are needed - a recurrent theme of the Austins. Some of these measurements are being made now at the University of British Columbia by McErlane et al. (1989), and Grondel et al. (1987) have published a pharmacokinetic analysis of OTC distribution in carp. In the absence of more detailed studies, humans ingesting farmed salmon may be receiving subtherapeutic doses of antibiotics. One would like to see regulations established for testing the product, by agencies, as it comes to market to ensure the absence of detectable residues. Methods used should be such as those approved by the National Committee for Clinical Laboratory Standards

used by the Clinical Laboratories, Laboratory Medicine, University Hospital, University of Washington.

The issue extends beyond the limits of the penned salmon. Much of the antibiotic fed escapes into the fluid environment and, notably, into the sediments that accumulate beneath the pens (Jacobsen and Berglund, 1988), where it may be exposed to native fish, shellfish, and other indigenous species, thus providing another avenue to humans who may catch and consume these forms.

The medical consequences of the mis-administration of antibiotics are numerous, and are well discussed in such modern treatises as Goodman and Gilman (1985) and Kucers and Bennett (1987). A number of them are antigenic and elicit immunological hypersensitivity responses; some have toxic effects in various tissues varying with the physiological and health state of the person; some particularly should be avoided during pregnancy; tetracyclines lead to discoloration of infants' teeth and may interfere with bone growth; some, notably the tetracyclines, may lead to the development of superinfections by resistant strains of bacteria; they may interfere with the normal immune response; and the breakdown products of antibiotics, including OTC, can be toxic particularly in individuals with compromised livers. Basically, it is poor medical practice to ingest unneeded antibiotics or deteriorating antibiotics.

Another cluster of problems associated with use and misuse of antibiotics is the generation of strains of pathogenic bacteria that have resistance to the drugs. Such strains have now appeared in essentially all fish culture communities that have been adequately tested. Mostly the resistance factors are carried on R plasmids, which also usually are found to carry resistance determinants for 1 to 8 additional antibiotics, thus showing multiple drug resistance. In high proportions, these R plasmids are transferable to other bacteria, and thus drug-resistance may be disseminated to other ecosystems. Studies at the Centers for Disease Control have shown that outbreaks of salmonellosis could be traced to drug-resistant *Salmonella* derived through the foodchain back to land farms associated with agricultural antimicrobial use (Cohen and Tauxe, 1986). It is prudent to evaluate the possibility for a similar generation of R plasmids in fish farms and their dissemination to human populations in the marketplace. When drug-sensitive populations of pathogens are replaced by drug-resistant populations, then treatment of the affected fish becomes ineffective, and, if the R plasmids are in human pathogens, treatment of patients would be adversely affected. Particularly, it is a general principle that medically important antibiotics, including oxytetracycline, the sulfas and erythromycin, should be restricted in their nonmedical uses to minimize R plasmid selection and transmission.

When antimicrobials are used in fish farms near commercial or recreational shellfish beds, there is the further potential for drug-resistant organisms to be concentrated by the shellfish, through filtration, and thus enter human populations.

Food additives. The dry pellets, fed to the penned fish in the marine environment, contain fish meal, grains, fish oils and carbohydrates, supplemented by minerals and vitamins as indicated in Table 2. While these additives have no direct human import, it is reported that planktonic blooms of

the ichthyotoxic dinoflagellate, *Gyrodinium aureolum*, were enhanced by the biotin in fish farm wastes (Turner et al., 1984). These blooms cause mortalities to cultured fish, and, unfortunately, to wild fish as well (Bullock et al., 1985).

Pigment is added to the feed to produce a colored flesh in farmed salmon, inasmuch as the color of wild salmon flesh is derived from natural food organisms. In Great Britain, the carotenoid canthaxanthin, an analog of astaxanthin common in natural food organisms, is used in the form of carophyll red. It is stated in a report from the University of Stirling that this use is banned in the US because of possible carcinogenic properties of canthaxanthin (NCC Report, 1988). To date a petition for its use has not been submitted to the FDA (FDA, Seattle Office, 1989). A petition is presently under consideration for use of astaxanthin as a colorant. A main local supplier adds canthaxanthin as a colorant. There clearly are gray areas here where research and regulation is sorely needed.

Many wild fish are rich in omega 3, polyunsaturated fatty acids. A higher ratio of omega 3/omega 6 fatty acids is believed favorable for maintaining low cholesterol levels in humans. Cultured fish and other sea foods, because of their artificial diets, may have low levels of omega 3 fatty acids, and thus unfavorable ratios of omega 3/omega 6 (Suzuki et al., 1986; Chanmugam et al., 1986). Consequently, individuals eating farmed salmon in the expectation of gaining this supplement will typically be erring, unless the farmer has specifically added it as a dietary supplement and indicated this in marketing. The dry pellets supplied locally generally do not have omega 3 acids added as a supplement (Moore-Clark Co., 1989, pers. comm.) because these are contained in the fish oils of the fish meal used.

Moist pellets, which are more commonly fed during the hatchery phases of salmon farming, are derived from fish meal that is pasteurized, combined with additives, and frozen. However, moist pellets used in some fish farms in Puget Sound contained *Salmonella* spp. (Draft PEIS, WDF, p. 116, 1989). Moist pellets used in British Columbia have been found to contain *Salmonella* (Kelly, 1988, pers. comm.; Babink, 1988, pers. comm.). In these cases it is unclear whether the pathogens had survived the pasteurization, or had appeared subsequently. These pathogens can persist for a period of time in marine waters, are harbored by fish in polluted waters, without harm to them (Buttiaux, 1963). Marine shellfish can concentrate *Salmonella* and transmit them to humans. There is, therefore, a potential for fish culture to join animal husbandry as a mode for affecting humans in the manner described by Cohen and Tauxe (1986).

Hormones. At this time, hormones are being used in B.C., experimentally and perhaps to an extent in actual culture, to control the sex, size and behavior of penned salmon, both *Oncorhynchus* spp. and *Salmo salar*. Gonadotropin, gonadotropin releasing factor and analogs, and antiestrogens have been used in adult females to modify spawning. Androgens and estrogens are used to cause feminization, and, in combination with other techniques, to produce triploid and tetraploid stocks for production of sterile salmon. A review is provided by Donaldson (1986).

In general, these treatments are used on egg-producing females or on eggs and sperm, and the likelihood of carry-over of hormones to adult, marketable fish is tiny. Anabolic steroids including methyl testosterone,

thyroid hormones, somatotropins, certain pituitary hormones can be used to accelerate growth in juveniles and the timing of smoltification (Donaldson, 1986). If these hormones, or androgens and estrogens, were used for growth acceleration or other effects on near-harvest adults, then there would be cause for concern to human consumers.

Pesticides. A remarkable list of agents are or have been used in salmon culture. Examples are: formalin, malachite green, acriflavin, Nuvan, Neguvon, Chloramine T, MS222, copper sulfate, tributyltin, diquat, in addition to the chemotherapeutics. Some are used in Scotland and Norway which apparently are not used, or not permitted, in the U.S. and B.C. Lists are incorporated into Table 1 of this presentation.

Treatment of salmon lice (*Lepeophtheirus salmonis*). These copepod ectoparasites pose a severe problem for adult penned fish in Scotland and Norway. In Europe, organophosphate pesticides (Nuvan^R (dichlorvos; Scotland) and Neguvon^R (trichlorfon which forms dichlorvos; Norway) are primarily used. Fish are treated by immersion in a concentration of 1 ppm for 1 hr, as needed. In 1984 39,600 lbs of Neguvon were used in Norway (Midtlyng, 1985). They are inhibitors of acetylcholinesterase activity in the cholinergic nervous system. These agents not only kill fish lice, but other crustacea in the environment as well, including commercially important species such as crabs, lobsters and mussels (Egidius and Moster, 1987), and they cause potentially serious problems to the treated fish (Davies and McKie, 1987; NCC Report, 1988). These agents are restricted by the EPA in the U.S. (Seattle EPA Office, 1989). In Washington, the carbamate Sevin^R (carbaryl) has been suggested for use for treatment of salmon lice, and it is used in oyster culture for controlling ghost shrimp. Sevin, also, is an inhibitor of acetylcholinesterase. Sevin has recently been restricted in parts of the United States, and its discharge is regulated by an NPDES permit. BRAVO (chlorothalonil), a fungicide has been suggested for and used recently on fishpen nets, a use banned by EPA because it is a class B carcinogen (EPA, Seattle, 1989).

Disinfectants and Antifoulants. Formalin and malachite green have been used for control of ectoparasites and fungi, usually in the fresh water phases of farming. Malachite green, a potential teratogen (NCC Report, 1988), is now banned. MS-222 is used under certain conditions for anaesthesia, but with a 21-day withdrawal period for clearance from tissues. Hatchery ponds are sterilized with chlorine.

To prevent fouling of nets by growth of algae and encrusting invertebrates, fish farmers have treated nets and pen structures with the antifouling agent, tributyltin (TBT). This substance, at exceedingly low concentrations, has a variety of adverse effects on marine invertebrates and perhaps on vertebrates (Bailey, D.S., 1987). When, in 1987, farmed salmon appeared in the Seattle markets carrying substantial amounts of TBT in their flesh, the state enacted a law prohibiting this use and partially eliminating it from use on boats. A similar law exists in the national statutes, in Great Britain and other parts of Europe. Despite this ban, a Canadian Governmental memorandum on August 11, 1988, titled "Private Salmon Hatcheries and Netpen Facilities, Some Serious Concerns" indicates that 25% of BC pens are still treated with unregistered boat hull paints, sometimes including TBT, which liberate

large quantities of particulate paint into the water, sometimes onto oyster beds, thus creating potential hazards for two kinds of aquacultured products.

If antifoulant is used on nets now, usually it is copper-based. Copper and other heavy metals are highly toxic to many marine invertebrates. Standards for permissible amounts of copper in farmed fish flesh appear to be lacking.

Summary. There are a number of chemicals and additives used in net pen culture now that have the potential for adverse human impact. Often these are used at the discretion only of the user, and with little or no external monitoring. There appears to be little or no input into this regulation by public health agencies.

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Table 1
Chemicals Used in Net Pen Culture of Fish
 (From Austin and Austin, 1986; The Nature Conservancy
 Report, Scotland, 1988; and other sources)

Chemotherapeutics

Oxytetracycline	Streptomycin
Romet 30 ^R (sulfadimethoxine and orhomprim)	Sulfisoxazole
Sulfamerazine	Kanamycin
Tribrissen ^R (trimethoprim)	Fumequine
Erythromycin	Chloramphenicol
Penicillin G	Chloramine T
Oxolinic acid	Acriflavin
Minocycline	Acetic acid
Clindamycin	Formalin
Kitasamycin	Malachite green
Rifampicin	Iodine
Hyamine 3500	Iodophor
Copper sulfate	Benzalkonium
	Nitrofurantoin

Pesticides

Dichlorvos (Nuvan^R, an organophosphate)
 Trichlorfon (Neguvon^R, an organophosphate)
 Carbaryl (Sevin, a carbamate; used in oyster culture)
 Diquat

Antifoulants and Disinfectants

Tributyl tin - now banned
 Copper paint
 Bitumen
 Chlorine
 Chlorothalonil

Anaesthetics

MS-222 (tricaine methane-sulfonate)
 Benzocaine
 Carbon dioxide

Food additives

Colorants-canthaxanthin
 Minerals
 Vitamins
 Omega 3 fatty acids

Table 1B
Doses of Antimicrobials Commonly Used in Salmon Net-pen Culture

Antimicrobial	Dose, mg/kg of fish/day	Days of Treatment
Oxytetracycline	75	10
Romet 30	50	5
Sulfamerazine	220	14
Tribriksen	30	10
Erythromycin	10-25, or unspecified	4-21

These regimens are repeated 2 or 3 times a year

Table 2
Mineral and Vitamin Food Additives
in Salmon Pellets

(Data from Nature Conservancy Council Report 1988, and
Moore-Clark Analysis)

Minerals

- Calcium phosphate
- Magnesium sulfate
- Sodium Chloride
- Potassium chloride
- Iron sulfate
- Zinc sulfate
- Copper sulfate
- Manganese sulfate
- Cobalt sulfate
- Chromium chloride
- Ethylenediamine dihydroiodide
- Selenium

Vitamins

- Thiamine hydrochloride
- Riboflavin
- Calcium pantothenate
- Niacin
- Pyridoxine hydrochloride
- Biotin
- Folic acid
- Cyanocobalamin
- Inositol
- Ascorbic acid
- Choline chorlide
- Menadione
- alpha tocopherol acetate
- p-aminobenzoic acid
- Retinol acetate
- Vitamin A
- Vitamin B12
- Vitamn D3
- BHA-BHT, antioxidant

Another study
conducted by
the firm doing
the cost of
production study

**MARKET ACCESS
AND
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B.C. FARMED SALMON**

FINAL REPORT

The DPA Group Inc.

MARKET ACCESS AND
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FINAL REPORT

Prepared for:

B.C. Salmon Farmers
Association

Prepared by:

The DPA Group Inc.
and Dr. J. Anderson
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File: 14487

February, 1987

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APPENDIX A: Existing and Potential Salmon Demand by State

APPENDIX B: Description of the Seafood Distribution System

SELECTED BIBLIOGRAPHY

1.0 STUDY PURPOSE AND METHODOLOGY

1.1 Purpose

Shifts in consumer tastes and preferences have led to an increased demand for seafood. In particular, demand for fresh seafood has been expanding at a faster rate than supply. This trend has stimulated aquaculture development worldwide. Aquaculture is capable of providing a consistent, year-round supply of fresh seafood.

One species that has responded favourably to culturing is salmon. Between 1981 and 1983, world production of all pen-reared salmon, Atlantic and Pacific, doubled from 12,132 to 24,512 tonnes. During this period, approximately 70% of the world production of farmed salmon was produced in Norway, which exports almost all of its production. Approximately 85% of Norwegian exports are distributed fresh on ice; the remainder is either frozen, smoked, or marinated.

In 1982, 20 countries received fresh cultured salmon from Norway. By May of 1985, this number had grown to 32. Recently, the U.S. became the largest importer of farmed salmon, a position previously held by France. Lucrative markets for fresh salmon have encouraged other regions, including B.C., to establish salmon farming and ranching industries. Producers in many of these producing regions are also looking to supply the large U.S. market.

British Columbia producers appear ideally situated to supply the North American market. However, marketing issues have yet to receive sufficient attention in the B.C. aquaculture community. Producers have been primarily concerned with establishing facilities, obtaining supplies of smolts and feed, and mastering the technical aspects of pen-rearing salmon. Market research to date in this area has been general in scope and has focussed on identifying key

parameters such as market size, growth trends, and experience of competitors.

To develop more meaningful market information, the B.C. Salmon Farmers Association (BCSFA) commissioned this study to develop a practical, action-oriented marketing plan for the Association and its members. The BCSFA was incorporated July 11, 1984 under the Societies Act of British Columbia to serve as a producers' organization dedicated to furthering the salmon farming industry and the interests of its members. In November, 1986, the Association membership totalled 72, representing approximately 95% of active salmon farmers in B.C.

Funding for this marketing study was provided under the Canada-B.C. Subsidiary-Agreement on Industrial Development, a joint federal-provincial agreement administered by the Department of Regional Industrial Expansion and the B.C. Ministry of Economic Development.

This study has three primary purposes:

- (1) to examine key demand and supply factors which affect market access and penetration;
- (2) to recommend strategies and methods in production, pricing, distribution, and promotion with a view to maximizing returns to farmed salmon producers;
- (3) to recommend a role for the BCSFA in the marketing area.

1.2 Methodology

The study was conducted in three phases. Phase I involved an analysis of existing marketing studies and production statistics. The objectives were to identify: major potential markets; key demand and supply conditions; factors affecting B.C.'s competitive advantage; and key product attributes that affect buyer's preferences.

Phase II developed the essential elements of a market access

and penetration strategy for the industry. This included an identification of target markets, and an overall product positioning strategy vis-a-vis competitive products. This was followed by recommended strategies for production, pricing, distribution and promotion.

Phase III examined the Association's role in marketing and developed a summary of the marketing plan and implementation schedule. Methodology is described in the following paragraphs.

Phase I

To identify key demand and supply conditions facing the B.C. industry, existing market studies and statistics on salmon aquaculture production were extensively reviewed. One of the primary sources of data for the first phase was a recent study conducted for the Pacific Region of Fisheries and Oceans Canada entitled Conjoint Analysis of the New England Salmon Market, by James L. Anderson. The primary objective of this research was to determine buyer preferences for salmon products in New England. New England was selected for consumer research because consumption of fish in this state, including salmon, is high and Norwegian producers have successfully introduced farmed Atlantic salmon product in that market.

Dr. Anderson extended the original conjoint analysis research in Phase I of the study to identify those market segments where B.C. farmed salmon would be most competitive.

Conjoint analysis treats a product or service as a bundle of attributes. It identifies which attributes are most important in the consumer purchase decision.

The attributes and attribute levels used to define salmon products are outlined in Exhibit 1.1. Combinations of these

EXHIBIT 1.1: ATTRIBUTES AND ATTRIBUTE LEVELS FOR SALMON PRODUCTS

1. Species
 - 1.0 Atlantic Salmon
 - 1.1 Silver (Coho) Salmon
 - 1.2 King (Chinook) Salmon
 - 1.3 Red (Sockeye) Salmon
 - 1.4 Chum Salmon
2. Source
 - 2.0 Canadian
 - 2.1 Norwegian
 - 2.2 New England
 - 2.3 Western US
 - 2.4 Scotland
 - 2.5 New Zealand
 - 2.6 Chile
3. Type
 - 3.0 Farmed (Ocean Pen-Raised)
 - 3.1 Wild, Troll Caught
 - 3.2 Wild, Gillnetted
 - 3.3 Wild, Seine Natted
4. Quality

4.0 Fresh:	Top Quality	- no discolouration in belly flesh - no cuts or scars/no fishy odor - 8+ day shelf life at 32 degrees
4.1 Fresh:	Good Quality	- little discolouration in belly flesh - 1 or 2 minor marks on fish/minor odor - 5-7 day shelf life at 32 degrees
4.2 Fresh:	Lower Quality	- discolouration in belly flesh (10%+) - some cuts or scars/fishy odor - 2-4 day shelf life at 32 degrees
4.3 Frozen:	Top Quality	- no discolouration in belly flesh - no cuts or scars/no fishy odor - 6 month shelf life frozen
4.4 Frozen:	Good Quality	- little discolouration in belly flesh - 1 or 2 minor marks or scars/minor odor - 3 month shelf life frozen
5. Size
 - 5.0 Head-on, Dressed 6-9 lbs
 - 5.1 Head-on, Dressed 9+ lbs
 - 5.2 Head-off, Dressed 4-6 lbs
 - 5.3 Head-off, Dressed 6-9 lbs
 - 5.4 Steaks 8-10 oz
 - 5.5 Portioned Fillets, 8-10 oz
 - 5.6 Portioned Fillets, 6-8 oz
 - 5.7 Head-on, Dressed, Pan sized
6. Colour
 - 6.0 Pale pink
 - 6.1 Pink red
 - 6.2 Deep red
7. Availability
 - 7.0 Consistent Supply May-November Only
 - 7.1 May-November Only with Frequent Shortages
 - 7.2 Consistent Supply Year Round
 - 7.3 Year Round with Frequent Shortages
8. Delivery
 - 8.0 Guaranteed 36 hr from Time of Order
 - 8.1 3-4 Days from Time of Order
9. Minimum Order Quantity
 - 9.0 10 lbs
 - 9.1 20 lbs
 - 9.2 50 lbs
 - 9.3 100 lbs
10. Price
 - 10.0 \$1.25/lb
 - 10.1 \$2.75/lb
 - 10.2 \$3.75/lb
 - 10.3 \$4.75/lb
 - 10.4 \$6.75/lb

attribute levels can be used to create a set of salmon products.

Through survey techniques, buyers in New England ranked and scaled a set of hypothetical salmon products, and then assigned a relative weighting to the importance of each individual attribute. Econometric analysis was then applied to determine a numerical value for each attribute.

By combining the scores of each attribute of a product, composite preference scores for a series of competitive products can be obtained.

The conjoint analysis model was used to evaluate and test a number of assumptions regarding buyer preferences. Specifically, we determined which of 77 competitive salmon products were preferred by three market segments. The segments analyzed were restaurants, fish shops and grocery supermarkets. Restaurants were further divided into four sub-segments.

The 77 salmon products involved various combinations of attributes including species, size, quality, price, product form, and country of origin. The list was composed of salmon products we expect the B.C., Norwegian, and other salmon farming regions, and the wild fishery, to deliver to the North American marketplace over the next few years.

The conjoint analysis model assigns a preference score (0-120) to each product. The major contenders for market share in each market segment are those with the highest scores. This provided one means of determining market segments in which B.C. farmed salmon would be most competitive.

The conjoint analysis model was also used to estimate potential demand for fresh and frozen salmon in North America.

Results from the conjoint analysis were used by Anderson to estimate current and potential demand for fresh and frozen salmon in every U.S. state, and major Canadian regions.

Phase II

The second phase of the study was devoted to a number of specific interviews to fill data gaps identified in Phase I.

We surveyed six salmon smokers in Vancouver and New York to investigate markets for secondary products and conducted several interviews with local representatives of major Japanese trading houses to determine the potential for exports to Japan.

To determine the quantity and nature of future supplies of B.C. farmed salmon, we interviewed eight Association members and five major processors in the traditional fishery. We also investigated future supplies of farmed salmon as well as competitive strategies of other producing countries by analyzing previous studies and interviewing industry experts.

To determine the distribution strategy that would maximize producer returns, we analyzed the seafood distribution system in North America. Our analysis included reviewing previous studies and conducting personal and telephone interviews with 15 fish brokers, wholesalers, and retailers in the major salmon trading centres of Vancouver, Seattle, San Francisco, Los Angeles, and Chicago.

We also analyzed transportation and distribution costs to service each target market identified.

Phase III

The third phase reviewed the results of a two-day workshop on quality control and grading of farmed salmon (sponsored

jointly by the B.C. Ministry of Agriculture and Fisheries and the BCSFA). This review became part of our recommendations with respect to product packaging and promotion strategies. We also examined the structure and promotional campaigns of several other fish farming Associations, including those in Norway, Scotland, Ireland, New Zealand, and the U.S.

In addition, we conducted interviews with the Fisheries Council of B.C. to assess the likelihood of joint promotion.

1.3 Report Organization

The structure of the report is outlined in Exhibit 1.2.

Sections 1.4 and 1.5 provide an introduction to the farmed salmon product and the markets in which it is sold.

Sections 2.0, 3.0, and 4.0 discuss the demand conditions relevant to selling B.C. farmed salmon. Potential export markets worldwide are discussed first (Section 2.0), followed by a detailed assessment of current and potential demand for fresh and frozen salmon by market segment in North America (Section 3.0). Finally, buyer preferences (for characteristics such as size, colour, species, and quality) are discussed for each market segment in Section 4.0.

Section 5.0 focuses on supply conditions. Supplies of salmon from B.C. and other regions are projected for the North American marketplace. Competitive strategies of other regions are discussed. Finally, the supply/demand balance over the short and long term and implications for prices are discussed.

Section 6.0 discusses marketing issues and problems related to marketing fresh seafood in North America. Demand-related, supply-related, and market structure/coordination issues are assessed.

EXHIBIT 1.2: OVERVIEW OF REPORT STRUCTURE

Overview of Product and Markets
(1.4 and 1.5)

Demand Conditions

- . World (2.0)
- . North America (3.0)
- . Preferences by Segment (4.0)

Supply Conditions

- . Projected Supplies by Producing Region (5.0)
- . Supply/Demand Balance (5.0)

Key Marketing Issues and Challenges
(6.0)

Product Positioning and Target Markets for B.C. Farmed Salmon
(7.0)

Product Strategy
(8.0)**Pricing Strategy**
(9.0)**Distribution Strategy**
(10.0)**Promotion Strategy**
(11.0)

BCSFA Marketing Role
(12.0)

Section 7.0 assesses B.C.'s competitive advantages and discusses potential target markets for B.C. production. Overall product and image positioning for the B.C. farmed salmon product is proposed.

Sections 8.0 to 11.0 present specific recommendations for product, distribution, pricing, and promotion strategies for the B.C. industry.

Section 12.0 presents recommendations for the role of the BCSFA in marketing.

1.4 Overview of the Product

World production of salmon in 1983, which is the most recent data available from the Food and Agriculture Organization, is shown in Exhibit 1.3. In 1983, world production totalled 688,522 tonnes. Atlantic salmon accounted for 4% of world production, the majority of which was farmed in Norway. Pacific salmon accounted for 96% of world production. Leading species were pink, chum, and sockeye.

EXHIBIT 1.3: WORLD PRODUCTION OF SALMON BY SPECIES IN 1983^a
(tonnes)

Atlantic		
wild	7,518	1%
farmed	<u>17,795</u>	<u>3%</u>
	25,313	4%
Pacific (wild)		
Chinook	19,784	3%
Chum	188,850	27%
Coho	34,445	5%
Pink	252,830	37%
Sockeye	164,000	24%
Masu	<u>3,300</u>	<u>-</u>
	663,209	96%
Total All Salmon	688,522	100%

^a World production of farmed Pacific salmon is not shown, but is estimated to be less than 1% of total salmon supplies.

Source: FAO Production Statistics (various).

Salmon farming falls into the broad category of aquaculture, which is the controlled cultivation and harvest of aquatic plants and animals. With salmon, a pen-rearing technique is usually employed. This involves raising salmon from smolts in pen or cage enclosures situated in marine locations. The grow-out period can take up to three years, although fish may be harvested within one year after introduction into seapens, depending on market and other conditions.

Three species of salmon are currently being cultured in various parts of the world; all three species are produced by the B.C. salmon farming industry.

The primary species being farmed in B.C. are two Pacific species: chinook and coho. Chinook (also known as spring or king salmon) is generally considered a premium quality salmon and, in the wild, usually weigh between 4 and 20 kilograms. Wild chinook are typically larger than either Atlantics or coho. Wild chinook are distinguished by their red flesh colour. The redness, plus high oil content, have made large chinooks a preferred species in the smoking trade both in Europe and North America.

Coho (also known as silver salmon) are generally available in sizes between 2 and 4 kilograms and have paler red flesh. Their smaller size is preferred in certain market segments.

Sockeye, which is also a premium fish in fresh/frozen form is not farmed due to biological constraints.

Atlantic salmon are also farmed to a small extent in B.C. waters. Atlantics are distinguished by an orange/red flesh colour.

Factors affecting the market for salmon products are complicated by the perception that seafood products are becoming increasingly heterogeneous and differentiated. In addition, markets for salmon are dynamic: new supply regions and the

advent of aquaculture allow consumers to purchase salmon in a variety of forms, sizes, quality levels, and prices.

The typical farmed salmon "product" has a number of distinguishing characteristics which are important in assessing its market potential. These include:

- . It is sold predominantly in a fresh form (dressed, head-on).
- . To date, it has been sold predominantly as a high-value, gourmet item to premium markets where high prices can be commanded (e.g., white table cloth restaurants).
- . It has a reputation in the trade for high quality, largely because it has a longer shelf life than wild products and has an excellent physical appearance (i.e., no cuts or bruises).
- . It is uniformly and consistently sized.
- . It has consistent prices.
- . It is potentially available year round, especially during the November-April period when no fresh wild-caught salmon are available.

Production forecasts for the B.C. salmon farming industry are shown in Exhibit 1.4.

EXHIBIT 1.4: PRODUCTION FORECASTS FOR THE B.C. SALMON FARMING INDUSTRY

Year	Tonnes
1986/87	1,000 ^a
1987/88	2,500 ^a
1988/89	10,000 ^a
1989/90	13,000 ^b
1990/91	16,000 ^b

Source: ^a B.C. Salmon Farmers Association.
^b The DPA Group Inc., Industrial Organization of The B.C. Salmon Farming Industry, 1986.

As shown in the exhibit above, production is projected to increase significantly during the next five years. In particular, substantial increases are projected for 1988.

There is considerable uncertainty about production estimates because of the newness of the industry and the uncertainty of the survival rates.

1.5 Potential Markets

Markets for salmon are actually a series of interrelated markets that currently consume a variety of species from different sources and in different product forms. For example, shortages of supplies of frozen sockeye from the U.S. and Canada in 1986 resulted in strong demand for frozen coho in Japan. B.C. farmed salmon therefore is not sold in a vacuum but in a complex market.

Most market analyses of farmed salmon focus on its consumption in a fresh and frozen form in two distribution channels:

- . the hotel, restaurant, and institutional (HRI) trade;
- . the retail sector, composed of grocery stores and specialty fish shops.

The importance of each market differs considerably by country. For example, the smoking trade is a more important outlet for farmed salmon in Europe than in North America.

Canned salmon, one of the predominant salmon product forms in North America, is not usually included in market potential analysis for farmed salmon because of lower selling prices. Canned salmon utilizes sockeye and lower-valued species of Pacific salmon other than those farmed (i.e., chum and pink, rather than chinook and coho).

Two further distinctions with respect to salmon markets are useful when investigating farmed salmon potential. The first relates to the fresh/frozen question. Much of the data on the consumption and trade of salmon combine statistics on fresh and frozen salmon. It is useful to separate the two forms for a number of reasons. First, the majority of farmed salmon is sold in a fresh form and the consumption of fresh is the fastest growing segment of total seafood consumption. Second, the competitive circumstances for fresh salmon may differ from those for frozen salmon. For example, fresh salmon does not compete with frozen salmon in certain segments of the HRI trade such as expensive seafood restaurants. Rather, it competes with other forms of fresh seafood.

The second distinction relates to individual species. Farmed chinook and coho primarily compete with their wild-caught counterparts and farmed Atlantics. These three groups of species command premium prices and are considered higher quality than chum and pink salmon.

Section 2.0 presents an overview of the major potential markets for B.C. farmed salmon. Unless otherwise stated, all dollars shown are expressed in U.S. dollars.

2.0 WORLD MARKETS FOR B.C. FARMED SALMON

2.1 Introduction to World Markets for Fresh and Frozen Salmon

The main market areas for salmon are Japan, Europe, and North America. Within Europe, the four largest markets are France, the U.K., West Germany, and Sweden. Smaller markets also exist in South Africa, Hong Kong, and Singapore.

Fresh and frozen salmon consumption by principal consuming countries is provided in Exhibit 2.1. As indicated in the exhibit, Japan has the largest per capita consumption of salmon. Japan consumes over 5 times as much salmon as the U.S. The U.S., in turn, consumes more fresh/frozen salmon in total than all of the principal salmon-consuming European countries combined.

EXHIBIT 2.1: CONSUMPTION OF FRESH/FROZEN SALMON IN 1983

	Consumption (tonnes)	Per Capita Consumption (kg)
	273,	2.33
North America		
U.S.	52,700	0.23
Canada	12,100	0.50
Europe		
France	21,100	0.39
U.K.	10,600	0.19
Sweden	6,800	0.82
Denmark	6,200	1.21
West Germany	5,300	0.09
Total	388,400	

% of Total Salmon Production

Worldwide (including canned) 56%

Source: derived from FAO statistics.

The main trading flows for fresh and frozen salmon of all types are shown in Exhibit 2.2. The exhibit provides further indication of the major consumption areas and the major sources of supply for salmon.

A significant trend occurring in the 1980s is the increase in consumption of fresh salmon. This trend is shown graphically in Exhibit 2.3, where the average annual percentage increase of imports of fresh salmon are compared to those for frozen salmon in major markets from 1981 to 1984. Fresh salmon imports have increased at a much faster rate than frozen salmon imports in each major market.

This trend results largely from the increased production of Norwegian farmed salmon as evidenced by the increased market share of fresh imports held by Norway in major markets. Norway now holds the largest share of fresh imports in each major market. In contrast, the market shares of frozen imports held by the U.S. and Canada have remained relatively static.

2.1.1 Japan

Japan is the world's largest salmon market and the largest importer. It currently consumes more than five times as much fresh and frozen salmon as the US, the next largest consumer.

In recent years, Japan's high seas catch has declined and imports have increased, from 8,300 tonnes in 1974 to 116,000 tonnes in 1985. This large increase is due to the loss of access to foreign fishing grounds as a result of the establishment by several countries of 200-mile fish zones in 1977. However, imports have also increased as a result of a growing demand for salmon by increasingly affluent Japanese consumers, and more favourable exchange rates. Moreover, domestic production is mostly chum and therefore, Japan must rely on U.S. and Canadian imports of sockeye to satisfy a large domestic demand for this specie. Japan's domestic

EXHIBIT 2.2: TRADING FLOWS FOR FRESH/FROZEN SALMON IN 1984

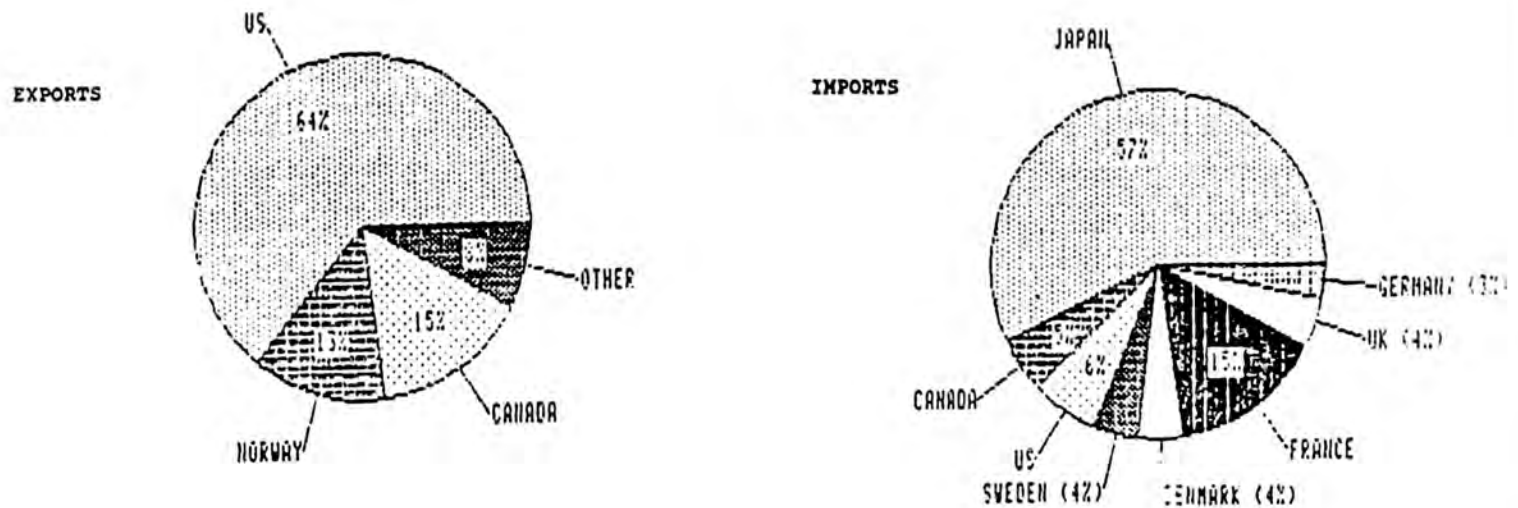
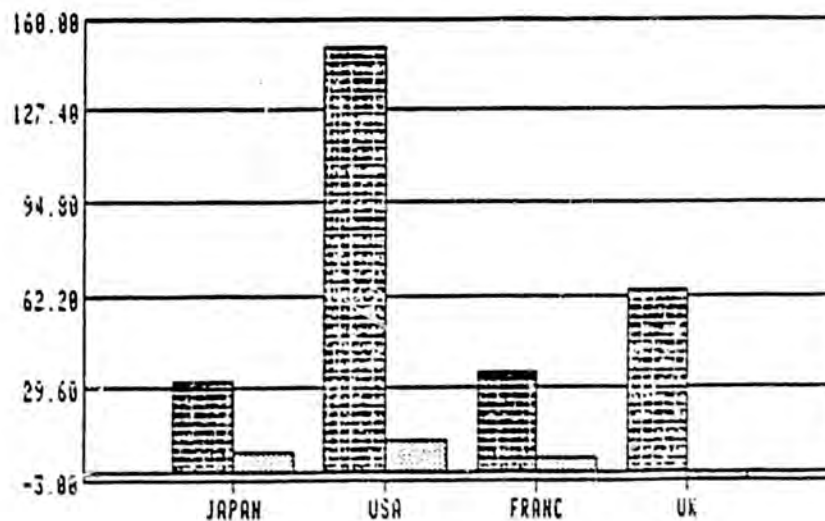


EXHIBIT 2.3: AVERAGE ANNUAL INCREASE IN IMPORTS OF FRESH SALMON IN MAJOR MARKETS (1981-1984)



 FROZEN
 FRESH

production of fresh/frozen salmon in 1983 was 178,000 tonnes, 75% of which was chum. Imports of fresh/frozen salmon were 90,000 tonnes, mostly sockeye from the U.S.

Salmon farming has also begun in Japan. Pen-raised coho production increased from 72 tonnes in 1978 to 6,430 tonnes in 1985. Production in 1985 represented about 2% of total salmon supplies.

The Norwegians have introduced farmed Atlantic salmon to Japan. Imports of fresh salmon from Norway in 1985 were 281 tonnes. Japan also imported approximately 11 tonnes of farmed salmon from the U.K. in 1985.

Despite the huge size of the Japanese market for farmed salmon, only limited penetration has been achieved by European exporters. Reasons for this include:

- . Traditionally, Japanese consumers have favoured salted and smoked salmon over fresh salmon.
- . Prices for imported farmed salmon are considerably higher than for other imports.
- . Atlantic salmon, which has a different flavour and colour than Pacific species, is not indigenous to Japan.

2.1.2 Europe

France

France is the largest salmon market in Europe. Salmon demand in France is growing steadily, particularly for fresh product. France is considered a species-conscious, well informed market where Pacific chinook and coho and Atlantic salmon have strong, established market positions. Canada is a significant supplier of wild frozen salmon to French smokers, accounting for 35% of frozen imports in 1984.

However, Canada's market share is showing signs of eroding, mainly due to declining catches. Also there is some substitution of farmed Atlantic salmon for frozen Pacific salmon occurring, particularly with smokers using coho. Farmed salmon offers attractive features to smokers such as lower inventory costs and higher yields. In contrast, chinook is likely to maintain its market niche because of its large size and high oil content.

Further market penetration by farmed Atlantics will depend very much on price. The fresh sector is also mature and well developed, and price will be important in determining future market developments. Large rainbow trout are particularly strong competitors in lower weight classes (1-3 kilograms).

In such a price sensitive market, the potential for fresh B.C. farmed salmon in France is severely limited by transportation cost disadvantages and poor proximity to market vis a vis Norwegian and U.K. production.

United Kingdom

Generally the U.K. is considered a primary market for canned salmon as well as a large market for fresh and frozen salmon. The U.K. salmon market has been expanding, due largely to a growing farmed salmon industry concentrated in Scotland. Production of U.K. farmed Atlantic salmon has increased from 600 tonnes in 1980 to 3,900 tonnes in 1984.

In recent years, Scottish farmed salmon and imports of Norwegian farmed salmon have eroded the market share held by frozen Pacific salmon. In particular, farmed salmon has replaced some of the position previously held by frozen Pacific salmon in smoking markets. A major factor affecting this has been the value of the U.S. and Canadian dollar relative to the British pound and the Norwegian kroner.

Other European Countries

Historically West Germany has been a low consumer of salmon. It imported and consumed about 5,500 tonnes of fresh/ frozen salmon in 1984. However, as in most other European countries, fresh Norwegian salmon consumption is increasing rapidly.

Denmark is a major centre for salmon smoking. However, most imports of fresh/frozen salmon from Norway, the U.S. and Canada are processed into smoked form, and exported. Imports were about 7,400 tonnes and exports were 5,500 tonnes in 1984. As a result, consumption in Denmark is low at about 1,900 tonnes in 1984. As in France and the U.K., farmed Atlantic salmon is increasingly being used by smokers.

Due to the increasingly entrenched position of European farmed salmon producers, it is unlikely that market penetration of farmed Pacific salmon could be easily obtained.

2.1.3 North America

United States

The market for fresh and frozen salmon in the U.S. in 1984 is shown in Exhibit 2.4. Domestic production of fresh and frozen salmon formed about 93% of the total available supply in 1984. However, only about 32% of this total was consumed in the U.S.; the majority of frozen salmon production was exported. The remainder of supplies were imported from the following sources:

- . 94% of the fresh imports of farmed salmon were from Norway in 1984. Small quantities were also imported from the U.K., Canada, and Chile.
- . 93% of imports of fresh wild-caught salmon were from

Canada in 1984. Chinook salmon constituted about 30% of these imports.

. Frozen imports of salmon were nearly all from Canada in 1984.

EXHIBIT 2.4: THE US MARKET FOR FRESH AND FROZEN SALMON IN 1984^a

IMPORTS			DOMESTIC	
Fresh Imports (farmed)	Fresh Imports (wild)	Frozen Imports	Fresh Domestic Production	Frozen Domestic Production (wild)
5,200 ¹	2,600 ¹	3,900 ¹	14,000 ²	139,800 ²
Total Available Supply				
165,500				
Exports (Frozen) ³			Fresh/Frozen Consumption	
102,600			62,900	

^a All figures are rounded.

Sources:

1. U.S. Department of Commerce.
 2. DPA estimates derived by aggregating catch statistics from Alaska, Washington, Oregon and California.
 3. FAO.
-

Canada

The Canadian market for fresh and frozen salmon consumed approximately 14,000 tonnes in 1984, the vast majority of which was wild-caught Pacific salmon from B.C. Despite being one of the largest producers of salmon in the world, Canada's per capita consumption of salmon is not high relative to many other industrialized countries.

Canada's market is also geographically dispersed. The largest markets are in large urban centres. As a result, demand is greatest in Central Canada. Although official statistics are not available for total per capita consumption of salmon by province, per capita consumption in B.C. is likely much higher than the rest of Canada. Recent surveys conducted by DFO on the number of fish caught by sport fishermen suggest that per capita consumption of salmon in B.C. is as high as in Japan.

Currently, Fisheries and Oceans Canada requires that imports from Europe of dead salmonids be certified free of two diseases: whirling disease and viral hemorrhagic septicemia (VHS). As of January, 1987 only one farm in Norway and two farms in Scotland produced farmed salmon with this certification. As a result, very little Norwegian and Scottish farmed salmon is imported into Canada. B.C. producers should therefore face less competition in the Canadian market than in the U.S.

The market for fresh and frozen salmon in Canada is segmented similar to that in the U.S., a factor discussed in detail in Section 3.0.

2.1.4 Overall Prospects for B.C. Farmed Salmon

Japan represents a huge potential market for B.C. producers, but the short-term potential for B.C. farmed chinook and coho salmon is limited. This conclusion was reached from interviews with representatives of four Japanese trading companies in Vancouver. (More detailed findings from these interviews are presented in Section 6.0.) The limited potential is due to the Japanese preference for deep red salmon (which farmed chinook and coho have yet to attain), the relatively high cost of B.C. farmed salmon, and the current limited consumption of fresh salmon.

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>	<u> </u>	<u> </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.¹

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	10,900	2,000	2,400	15,300	18
	<u>43,200</u>	<u>14,100</u>	<u>15,400</u>	<u>72,700</u>	<u>84%</u>
	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	800	300	200	1,200	1
	<u>8,900</u>	<u>2,900</u>	<u>1,700</u>	<u>13,500</u>	<u>16%</u>
	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% (157% of 1985) at current prices

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

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	700	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
---	---	--	---	---	---	------------------

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.

4.0 BUYER PREFERENCES BY MARKET SEGMENT

This section discusses North American buyer preferences for fresh and frozen salmon. The product characteristics or attributes considered the most important by the restaurant and retail market segments are discussed. Then the results from Anderson's conjoint analysis are extended to analyse the extent to which B.C. farmed salmon products might be more (or less) preferred in each market segment compared to competing wild and farmed products. This indicates what types of B.C. farmed products are likely to be the most competitive in each market segment.

The results of this analysis are used later in developing recommended product and promotion strategies.

4.1 Purchase Criteria

Any salmon product can be viewed as a bundle of attributes or characteristics. Species, size, colour, product form, quality level, price, country of origin, and availability are examples of the features buyers may consider important in their purchase decision. The important attributes differ across market segments. For example, retail segments are very price conscious and concerned about consistent availability; white table cloth restaurants are more concerned with freshness, quality and size. The key to an effective marketing strategy is to match (or adapt) product characteristics with the demands of particular market segments. Extending the above examples, this strategy means not marketing high cost, 12-pound chinook available only six weeks a year to the retail segment. Similarly, inexpensive two to four pound early maturing coho should not be sold to upscale seafood restaurants.

This section summarizes the results of recent market research with respect to the most important product attributes in each

market segment. This is useful in several ways. First, comparing these characteristics with expected B.C. supply over the next five years will indicate the most promising opportunities. Second, it suggests the important characteristics that should be stressed in product promotion. Third, it indicates features that could be incorporated in future product design, an important point. Control over the product gives salmon farmers the ability to modify or change their products to meet changing market demands.

The following paragraphs describe the general characteristics of the restaurant and retail segments and the characteristics of the salmon product considered most important by buyers in each segment. The purchase criteria of brokers/ wholesalers are also discussed.

One point needs to be qualified before reviewing current market research. This research identifies product preferences as they exist today. Tastes and preferences change over time, and can be modified by advertising and promotion. This points to the need to continually monitor tastes and preferences in the marketplace. However, the information is based primarily on Anderson's research in 1986 and in New England which is considered ahead of other areas in terms of seafood consumption trends. The results are therefore indicators of general trends in North America.

4.1.1 The Hotel, Restaurant, and Institutional (HRI) Trade

General Characteristics

This segment absorbs approximately 60% of all fresh and frozen salmon sales. The segment is broadly split between three groups: the fast food industry; the low-priced coffee shop, cafeteria, and institutional trade; and medium to high-priced family and fine dining restaurants. Although approximately 35% of all fish sales are made to the first two sub-segments, only about 10% of this total is salmon. These

sub-segments are highly price conscious, and therefore purchase only lower-priced salmon. As a result, about 90% of salmon sales to this segment are to medium and high-priced restaurants.

Anderson's conjoint analysis further separates the medium to high priced restaurant segment into four categories:

Type of Restaurant	Average Price of Entrees
Seafood	
Expensive	>\$11.30
Non-expensive	<\$11.30
Non Seafood	
Expensive	>\$11.30
Non-expensive	>\$11.30

As will be shown, each type of restaurant has different preferences when purchasing salmon.

Restaurants usually operate with fixed menus, and therefore require reliable supplies. Because fish supplies are generally less reliable than meat or poultry, markups on fish tend to be higher. Chefs tend to do the buying for restaurants. Several suppliers typically supply all seafood requirements.

One of the important features of the HRI segment is the diverse and decentralized purchasing of products. Even large hotels and restaurants that are part of a chain typically buy fish locally from a wholesale outlet.

Gourmet restaurants have strong preferences for fresh fish which generally override their preference for particular species, and many do not substitute between fresh and frozen salmon. As a result, the main competitive products for B.C. farmed salmon will be other sources of farmed salmon, wild fresh salmon in the June-October period, and other premium-priced seafood items (e.g., swordfish, halibut, lobster, crab etc.).

Purchase Criteria -- HRI Sector

The most preferred combination of product attributes for each segment of the HRI sector are shown in Exhibit 4.1. These are largely based on conjoint analysis carried out by Anderson, supplemented with information from other sources (e.g., Ference 1986). A brief interpretation of the findings presented in Exhibit 4.1 follows.

The two most important purchase criteria in the restaurant segment are **fresh** (as opposed to frozen) product and **overall quality level**. These will probably not come as a surprise to anyone in the salmon farming business. The importance of a fresh product, however, has some critical implications that may not be obvious. For example, freezing a farmed product will greatly reduce its market attractiveness. The short product life of a fresh, perishable item means that orderly production scheduling and efficient distribution are all important if maximum producer returns are to be achieved.

Although fresh salmon is generally preferred, it depends on its expected shelf life (which is a proxy for quality). For example, inexpensive non-seafood restaurants prefer a frozen, top quality (6-month shelf life) product to a low or medium quality (3-4 day shelf life) fresh product. This is consistent with the fact that fast food and inexpensive restaurants often use frozen products because of ease of handling and more consistent supply and prices.

With respect to **type** (wild vs farmed), wild-caught salmon are preferred to farmed salmon in most market segments. This is a significant finding with regard to promotion programs.

With respect to other purchase criteria, **product form** is important. The importance of product form (which incorporates both size class and product type -- whole, head on/off, fillet or steak) has significant implications for marketing strategy. Each restaurant type exhibited different

EXHIBIT 4.1: SALMON PRODUCTS MOST LIKELY TO BE HIGHEST SCALED: RESTAURANTS

	Seafood Entree > \$11.30	Seafood Entree ≤ \$11.30	Non Seafood Entree > \$11.30	Non Seafood Entree ≤ \$11.30
Species	Chinook (King)	Atlantic Sockeye or Chinook	Atlantic or Coho	Sockeye or Coho
Country of origin	Western U.S.	Norway	Norway (Not West U.S.)	Norway (Not New England, Chile or Canada)
Type (wild vs farmed)	Indiff.	Wild	Wild	Wild
Fresh/Frozen	Fresh	Fresh	Fresh	Fresh
Quality	Top Quality (n.s.)	Top Quality	Top Quality	Top Quality
Shelf Life	8+ days (n.s.)	8+ days	8+ days	8+ days
Product Form	Whole, head-on or head-off	Whole, head-off, fillets	Whole, head-off	Steaks or fillets
Weight	9+ lbs.	9+ lbs. (8-10 oz.)	9+ lbs.	8-10 oz.
Color	Indiff. (n.s.)	Indiff. (n.s.)	Indiff. (n.s.)	Indiff. (n.s.)
Yr. Rd./Seasonal	Indiff. (n.s.)	Indiff. (n.s.)	Seasonal	Indiff. (n.s.)
Consistent/Shortages	Consistent	Consistent	Indiff. (n.s.)	Consistent
Delivery Time	3-4 days	Indiff. (n.s.)	Indiff. (n.s.)	Indiff. (n.s.)
Minimum Order	10 lbs.	10 lbs.	10 lbs.	10 lbs.
Price	low as possible	market (n.s.)	above market	market (n.s.)

* (n.s.) = not significant

Source: Anderson (1986)

preferences in this regard.

The expensive seafood restaurants preferred large (6-9 or 9+ lbs) head-on fish, while less expensive seafood and non-seafood restaurants prefer a pre-cut (fillet or steak product), presumably for convenience, portion control and ease of preparation. Filleting and/or steaking before export may not be feasible unless sales are direct to retailers and/or restaurants because of lower shelf life and problems with quality assurance (i.e. quality of a whole fish is easier to detect). At the very least, more cutting and pre-packaging of fish at the wholesaler distributor level needs to be further explored as a means of increasing market share. Pre-cut fresh fish definitely appears to be a trend of the future that other producer countries are seriously examining.

With respect to **species**, the most significant preference ranking existed in the expensive restaurant class, where chinook were strongly preferred. Most of the other three restaurant sub-segments were relatively indifferent among species, perhaps due to general lack of experience and familiarity with salmon. To these groups, the marketing adage "a salmon is a salmon is a salmon" might best apply. This means initially that Pacific salmon species will have no particular positive or negative image vs Atlantics among these market segments.

Colour is a controversial attribute in salmon marketing. Anderson's research indicates that it is a relatively insignificant factor in the salmon purchase decision among Eastern US buyers. This contradicts the conventional wisdom of salmon marketing on the Pacific Coast which has operated under the familiar "the redder, the better" adage in terms of flesh colour. Further discussion with US fish brokers during the study provides the following insights with respect to the issue.

First of all, it appears that flesh colour is used as an

indicator of overall product quality and value, especially in Western U.S. markets familiar with Pacific salmon species. It appears most critical that the flesh colour not be pale pink, or have a bleached, whitish appearance. Achieving a deep red flesh colour may be useful in visually differentiating the B.C. product from its paler Norwegian Atlantic counterpart.

Minimum order size emerged as an important purchase criterion in the restaurant segment. To a large extent, this attribute is controlled at the distributor/wholesaler level. From the buyers in the restaurants' perspective, the smaller the weekly order, the better. While the economics of distribution determine the ability of distributors to satisfy this requirement, it is nonetheless a product characteristic that should be discussed with distributors.

One attribute not possible to accurately evaluate in Anderson's research was taste. Taste preferences among individual consumers will vary widely. Several industry observers contended that the farmed product to date is characterized by a milder, blander taste than its wild counterpart. There were dissenting opinions on the effect of this on marketing success. Some felt that it would make it difficult to market to traditional salmon consumers. Others felt that its milder flavour would increase its likelihood of acceptance among the growing numbers of new salmon (and fish) consumers.

4.1.2 Retail Segment (Grocery/Supermarket and Specialty Fish Stores)

General Characteristics -- Grocery/Supermarket

Sales to this segment represent approximately 20% of all fresh/frozen salmon sales in North America. Fresh/frozen and canned fish products are normally sold separately in grocery stores in separate sections. Fresh seafood counters are a

recent innovation in major chain stores. They have been one of the most successful of the specialty shop/counters now found in many grocery stores and the larger, one-stop superstores.

Supermarket chains utilize centralized ordering and warehousing facilities. They also generally establish listed products, which will be warehoused at a central location. The individual store managers then generally select products from this list. Although fresh fish may not be purchased in this fashion, grocery chain stores may offer the advantage of more centralized buying points, relative to other segments.

General Characteristics -- Specialty Fish Stores

Fish stores, on average, represent 20% of the fresh and frozen salmon market in North America. Retail fish shops represent a knowledgeable buyer group. Traditionally in this segment, emphasis is placed on the availability of a wide range of fresh seafood products. Retail fish shops carry higher-valued fish products than grocery chainstores. As a buyer group, they are highly de-centralized, i.e. represented by large numbers of single-outlet enterprises. As a result, they command less buying power than grocery chainstores. Also, they typically use more suppliers than chain store operations.

Generally, retail fish shops have full-service counters. They prefer to do their own cutting and therefore prefer whole dressed salmon. As a result, they impose higher markups than supermarkets.

More competitive products exist in this segment than other segments, and it sells a higher proportion of fresh product than other segments.

Purchase Criteria - Retail Segment

The most preferred product characteristics for the two retail market segments are presented in Exhibit 4.2. An interpretation of these findings with respect to B.C. farmed salmon is discussed below.

Similar to the restaurant segment, quality and freshness were top-ranked criteria. It is important to note that price was ranked more importantly in the grocery/supermarket segment than in either fish stores or restaurants. This is consistent with the price and margin consciousness of large volume retailers. This does not necessarily mean that retailers will pay lower prices than other segments. However, it does mean that pricing will be more competitive, and retailers will be more prone to switch among suppliers and substitute products on the basis of price.

For example, retailers will be less likely to carry farmed products when less expensive, wild products are available. It also means that "previously frozen" product might be offered as a competitive substitute for the fresh farmed product in the winter period.

The wide range of substitutes and price consciousness has prompted many industry analysts to contend that real prices will have to decline before farmed salmon penetrates the grocery store market to any significant extent.

Species was not deemed a significant purchase criterion among the grocery/supermarket segment. Coho was slightly preferred among the grocery/supermarkets, but probably due to the fact that the descriptive word "silver" has positive connotations. In general, this segment is not well informed about salmon species. The more knowledgeable fish store segment, however, exhibited a slight preference for chinook or coho, probably due to their traditional exposure to wild Pacific varieties.

**EXHIBIT 4.2: SALMON PRODUCTS MOST LIKELY TO BE HIGHEST
SCALED: RETAIL SEGMENTS**

	Fish Shops	Grocery Stores
Species	Chinook (King)	Coho (Silver)
Country of Origin	Norway (not Canada, Chile or Scotland)	Indifferent
Type (Wild vs Farmed)	Indifferent	Indifferent
Fresh vs Frozen	Fresh (but shelf life important)	Fresh (n.s.)
Quality	Top Quality	Top Quality (n.s.)
Shelflife	8+ days	8+ days
Product Form	Whole (not fillets/steaks)	Fillets (8-10 ounces)
Preferred weight (if not cut)	Smaller sizes (n.s.) (2-3 kg)	Smaller sizes (2-3 kg)
Colour	Indifferent (n.s.)	Indifferent (n.s.)
Year Round/seasonal	Year round	Indifferent (n.s.)
Consistent/shortages (n.s.)	Shortages are ok	Indifferent
Price	Market Price	Very price and margin conscious

n.s. = not significant

Source: Anderson (1986) and Ference (1986)

Product form again was a significant purchase factor in the grocery/supermarket segment. Buyers indicated the strongest preference for a pre-cut product, such as an 8-10 ounce fillet. With respect to whole fish, the retail segment generally prefers smaller fish than the restaurant segment. Ference (1986) reported that 70% of grocery trade purchasers preferred salmon under 3 kg with the most popular range in the 2-3 kg range. This has important implications for the B.C. farmed coho sales.

Retail fish stores prefer both whole, head-on fish and generally larger size classes than the grocery/supermarket segment. This is because fish stores prefer to do their steaking and filleting, and the larger size classes produce better yields.

The ability to supply salmon year round versus seasonally was not a particularly important attribute for determining product preference, according to Anderson's research. Chain retail stores have traditionally been willing to switch among species and/or supply sources throughout the year to maintain fresh product for their customers.

The issue of supply continuity and availability of fresh product is a more important factor in the relationship between the distributor/wholesaler and the retail store, than between the individual farmer/producer group and the retailer (unless one plans to sell directly). However, many industry analysts feel that the inability of the seafood industry to provide consistent, year-round supply of high quality product is a major reason why North American seafood consumption is so low. Thus, supply continuity and year-round availability may be more critical in stimulating overall demand than in determining preferences for individual products.

Subsequent interviews with brokers and retail segment buyers indicated some critical aspects of product availability that will be essential in marketing on a large scale to large

retail grocery chains. These factors were: consistent supply over an extended period of time and the capacity to supply minimum volumes on a weekly basis. It is apparent that before chain stores will effectively promote products in their weekly promotional flyers, they need the assurance of large minimum volumes for extended periods of time. The salmon farming industry has generally been unable to meet these requirements to date.

4.1.3 Wholesalers/Distributors/Brokers

Purchase Criteria

The purchase criteria of this segment are important to salmon producers because they constitute a critical point of sale in the distribution chain. Salmon producers usually will be selling their product to this group, who in turn sell and distribute it further down the chain to the end-consumer. In theory, this segment's preferences should reflect those of the restaurant and retail markets they serve. However, it is important to identify any particular preferences they may have due to the nature of the services they provide.

Consistency of both supply and prices was considered the most critical by this industry segment. To market effectively and service their restaurant and retail clientele, the ability to forecast available supply, and receive it on a consistent basis, were key requirements. In addition, price considerations are more important to this segment than other parts of the distribution chain due to the low margins and competitive aspects of their industry.

Consistency in prices over time was also deemed important. The remarkable consistency of Norwegian landed prices in the US over the period 1982-1985 easily met this requirement.

Consistency in both supply and prices gives distributors much more capability to promote and forward sell the product.

Many industry analysts feel that these potential characteristics of farmed salmon provide tremendous scope to expand sales without serious pressure on prices.

4.2 Preferences Among Salmon Products

This section assesses the preference for actual competing products by market segment. This analysis indicates what type of B.C. farmed salmon products would be most competitive in each market segment. It is based on an extension of Anderson's conjoint analysis research.

Based on interviews with BCSFA members and brokers in Seattle, San Francisco, Chicago, Los Angeles and Boston, 77 salmon products were defined in terms of specific attribute levels. The possible attribute combinations that produce different salmon products was drawn from Exhibit 1.1 (e.g.: B.C. farmed coho, 4-6 pounds, 8-day shelflife, etc.).

Included in the list were B.C. farmed chinook and coho and expected competing products, such as Norwegian, Chilean and Scottish farmed salmon, and a variety of wild salmon products.

Each product (as defined by its attributes) was inserted into conjoint analysis scale equations to produce a preference score (0-120) in each of the six market segments. The higher the preference score, the more preferred the product, and the greater the likelihood that the buyer would choose it over a lower scoring competitor.

Confidence intervals around the highest ranked products in each sub-group were used to establish cut-off values. Competitive products scoring above the cut-off values were considered insignificantly different than the highest ranked product. This process effectively established the set of major contenders for each market segment.

For example, in the expensive seafood restaurant segment, the highest ranked product in the winter period was a Canadian, farmed, top quality, eight-pound chinook. It earned a preference score of 93. The standard error of prediction was ± 12 scale points, so any product scoring 81 or higher was considered insignificantly different than the highest ranked market product. The predicted contenders for market share in each restaurant and retail segment are displayed in Exhibits 4.3 to 4.8 (at the end of this section). For each segment and subsequent, scores are shown for products which are identified by specie, method of production [farmed vs. wild] and country of origin. The other attributes identified in Section 1.2 for each salmon product are not identified in the exhibits. In other words, some products in the exhibits may seem identical, but in reality have some differing attribute.

Canadian farmed product emerged as a contender for market share in all but one restaurant subsegment. The following observations can be made about the contenders in each market segment.

Expensive Seafood Restaurants

- . Five of the seven contending products in the winter are farmed Chinook from Canada (B.C.). Even with a five-day shelf life, lower quality B.C. Chinook was one of the preferred products. The significant variable here is the species, Chinook, not the country of origin.
- . During the summer period, no farmed products are preferred. The contending products are all U.S. troll-caught Chinook. This indicates that the dominant purchase criteria are species (Chinook) and method of catch (troll-caught), the latter being a proxy for quality.

Non-Expensive Seafood Restaurant

- . Norwegian farmed Atlantic products are preferred in both summer and winter.
- . This is the only segment where B.C. farmed product was not a contender. However, a filleted Canadian product would receive a higher preference rating than a whole Norwegian product.

Expensive Non-Seafood Restaurants

- . Norwegian farmed Atlantic product is predominant in this category, perhaps due to their prevailing market reputation for quality. As well, this was one segment where the Canadian origin attribute was significantly negative. However, this likely does not extend to B.C. so much as to the East Coast which has a poorer reputation for quality. In addition, farmed (as opposed to wild) salmon dominates this segment in winter or summer.

Non-Expensive, Non-Seafood Restaurants

- . This segment features the largest number of contending products. This perhaps indicates that because of little experience with salmon products, no firmly established purchase criteria exist.
- . While farmed products appear to dominate in winter and summer, a wide variety of species and countries of origin exist.

Fish Stores

- . A number of contending products exist here (e.g. nine insignificantly different products in the winter). This

is consistent with the practice of fish stores offering more product variety than other segments.

- . Farmed Chinook in a variety of sizes and product forms dominates both the winter and summer markets. It is interesting to note that farmed Chinook is preferred in presumably the two most informed segments about salmon: fish stores and expensive seafood restaurants.
- . All products demanded were whole, not pre-cut fish.

Grocery/Store Supermarkets

- . Coho (Silver) was the most preferred species, both winter and summer. This might be because buyers in this group (in New England) typically are not well-informed about salmon species, and the word silver has positive connotations, not the actual species.

4.3 Summary and Implications for B.C. Farmed Salmon

The conjoint analysis of preferences for salmon products indicates good market potential for B.C. farmed salmon in the U.S. B.C. farmed salmon products that match the quality and size characteristics of their competitors would be strong contenders for market share in every market segment.

B.C. farmed chinook enjoyed the highest preference ranking in the expensive restaurant segment, where Norwegian salmon has enjoyed its greatest success. This lends further support to the contention that Norwegian salmon has essentially been filling a supply vacuum that existed for fresh salmon in the winter period. Experienced U.S. salmon buyers still appear to prefer indigenous Pacific species such as chinook, provided that comparable quality attributes to other farmed sources are supplied. This is a critical requirement. The product strategy recommended in Section 8.0 discusses how this requirement can be met.

*Seems likely that if quality AK Salmon
would also be competitive*

Non-Expensive Seafood Restaurant

- . Norwegian farmed Atlantic products are preferred in both summer and winter.
- . This is the only segment where B.C. farmed product was not a contender. However, a filleted Canadian product would receive a higher preference rating than a whole Norwegian product.

Expensive Non-Seafood Restaurants

- . Norwegian farmed Atlantic product is predominant in this category, perhaps due to their prevailing market reputation for quality. As well, this was one segment where the Canadian origin attribute was significantly negative. However, this likely does not extend to B.C. so much as to the East Coast which has a poorer reputation for quality. In addition, farmed (as opposed to wild) salmon dominates this segment in winter or summer.

Non-Expensive, Non-Seafood Restaurants

- . This segment features the largest number of contending products. This perhaps indicates that because of little experience with salmon products, no firmly established purchase criteria exist.
- . While farmed products appear to dominate in winter and summer, a wide variety of species and countries of origin exist.

Fish Stores

- . A number of contending products exist here (e.g. nine insignificantly different products in the winter). This

EXHIBIT 4.3: PREFERRED SALMON PRODUCTS IN EXPENSIVE SEAFOOD RESTAURANT SUB-SEGMENT

WINTER								
PRODUCT	Chinook, farmed, Canada (8lbs)	Chinook farmed, Canada (11lbs)	Chinook farmed, frozen Canada (8lbs)	Chinook farmed, Canada (8lbs and GQ)	Chinook farmed, Canada (8lbs)	Chinook farmed, Canada (8lbs)	Chinook farmed New Zealand (8lbs)	Atlantic farmed Norway (11lbs)
Preference Score	93	89.4	89.1	89	88.2	85.2	84.6	81.5
Price/lb	\$5.00	\$5.50	\$3.50	\$4.00	\$4.50	\$4.50	\$4.50	\$5.00

SUMMER				
PRODUCT	Chinook, troll, US (11lbs, hd.off)	Chinook troll, US (8lbs, hd.off)	Chinook troll, US (5lbs, hd.on)	Chinook troll, US (11lbs, hd.on)
Preference Score	131.2	124	122.4	120.4
Price/lb	\$3.50	\$3.00	\$2.50	\$3.00

*Note significantly higher
pref scores and lower prices
for US chinook during summer.
Prefers for 11-15 lb large red,
most likely CA products
WA
OR*

Notes: All farmed products are "Top" Quality (8+ days shelflife) unless other noted.
"Good" quality (GQ) is a 5-day shelflife product.

**EXHIBIT 4.4: PREFERRED SALMON PRODUCTS IN NON-EXPENSIVE
SEAFOOD RESTAURANT SUB-SEGMENT**

WINTER

PRODUCT	Atlantic farmed, Norway (11lbs)	Atlantic farmed, Norway (8lbs)	Atlantic farmed, Norway (5lbs)
Preference Score	104.6	102.9	101.1
Price/lb	\$5.50	\$5.00	\$4.50

SUMMER

PRODUCT	Atlantic farmed, Norway 11lbs	Atlantic farmed, Norway 8lbs	Atlantic farmed, Norway 5 lbs
Preference Score	104.6	107.9	101.1
Price/lb	\$5.50	\$5.00	\$4.50

Notes: All farmed products are "Top" Quality (8+ shelflife) unless other noted. "Good" quality (GQ) is a 5-day shelflife product.

EXHIBIT 4.5: PREFERRED SALMON PRODUCTS IN EXPENSIVE NON-SEAFOOD RESTAURANT SUB-SEGMENT

	?		WINTER				?		
			all farmed (= quality)						
PRODUCT	Coho farmed, <u>frozen</u> Canada (8lbs)	Atlantic farmed, Norway (11lbs)	Atlantic farmed, Norway (8lbs)	Atlantic farmed, Canada (11lbs)	Atlantic farmed, Norway (5lbs)	Chinook farmed, <u>frozen</u> Canada (8lbs)	Atlantic farmed Canada (8lbs)	Atlantic farmed Canada (5lbs)	
Preference Score	78.3	75.1	73.0	71.4	70.8	70.8	69	66.8	
Price/lb	\$3.50	\$5.50	\$5.00	\$5.00	\$4.50	\$3.50	\$5.00	\$4.50	
			SUMMER						
PRODUCT	Coho farmed, frozen, Canada (8lbs)	Atlantic farmed, whole Norway (11lbs)	Atlantic farmed, whole Norway (8lbs)	Atlantic farmed, Canada (11lbs)	Atlantic farmed, Norway (5lbs)	Chinook farmed, frozen Canada (8lbs)	Atlantic farmed Canada (8lbs)	Atlantic farmed Canada (5lbs)	
Preference Score	78.3	75.1	73	71.4	70.8	70.8	69	66.8	
Price/lb	\$3.50	\$5.50	\$5.00	\$5.50	\$4.50	\$3.50	\$4.00	\$4.50	

*all farmed
(= quality)*

EXHIBIT 4.6: PREFERRED SALMON PRODUCTS IN NON-EXPENSIVE NON-SEAFOOD RESTAURANT TO SUB-SEGMENT

PRODUCT	WINTER										
	<i>Pan size?</i> Coho farmed, US (5lbs)	Coho farmed, Canada (8lbs)	Coho farmed, Canada (5lbs)	Atlantic farmed, Scotland (8lbs)	Atlantic farmed, Canada	Chinook farmed, Canada (11lbs)	Coho farmed, froz. Canada (8lbs)	Atlantic farmed, Canada (8lbs)	Atlantic farmed, Norway	Chinook farmed, Canada (8lbs)	Atlantic farmed Canada (5lbs)
Preference Score	113.7	109.9	106.8	103.8	103	101.7	100.8	99.8	98.8	98.6	96.6
Price/lb	\$4.00	\$4.50	\$4.00	\$5.00	\$5.00	\$5.50	\$3.50	\$5.00	\$5.50	\$5.00	\$4.50

PRODUCT	SUMMER														
	Coho farmed, US (5lbs)	Coho farmed, Canada (8lbs)	Coho farmed, Canada (5lbs)	Atlantic farmed, Scotland (8lbs)	Atlantic farmed, Canada (11lbs)	Chinook farmed, Canada (11lbs)	Coho farmed, froz. Canada (8lbs)	Atlantic farmed, Canada (8lbs)	Atlantic farmed Norway	Chinook farmed, Canada (8lbs)	Atlantic farmed Canada (5lbs)	Coho troll, US (8lbs)	Coho troll, Canada (8lbs)	Coho troll US (8lbs)	Chinook troll US (8lbs)
Preference Score	113.7	109.9	106.8	103.8	103	101.7	100.8	99.8	98.8	98.6	96.6	100.6	99.9	98.8	96.9
Price/lb	\$4.00	\$4.50	\$4.00	\$5.50	\$5.00	\$5.50	\$3.50	\$5.00	\$5.00	\$5.00	\$4.50	\$3.00	\$3.50	\$3.50	\$3.50

EXHIBIT 4.7: PREFERRED SALMON PRODUCTS IN FISH STORES SEGMENT

WINTER									
PRODUCT	Coho farmed, Canada (TQ)(5lbs)	Atlantic farmed, Norway (GQ)(5lbs)	Atlantic farmed, Norway (8lbs)	Atlantic farmed, Norway (11lbs)	Atlantic farmed, Scotland (8 lbs)	Coho farmed, Chile (5 lbs)	Chinook farmed, Canada (8lbs)	Atlantic farmed, Canada (5lbs)	
Preference Score	87.1	80.8	80.4	80	77.8	74.3	73.8	70	
Price/lb	\$4.00	\$4.50	\$5.00	\$5.50	\$5.00	\$3.50	\$4.50	\$4.50	
<i>pay more for lower quality Norwegian TQ Cdn</i>									
SUMMER									
PRODUCT	Coho farmed, US (TQ)(5lbs)	Atlantic farmed, Norway (GQ)(5lbs)	Atlantic farmed, Norway (8lbs)	Atlantic farmed, Norway (11lbs)	Atlantic farmed, Scotland (8lbs)	Coho farmed, Chile (5lbs)	Chinook farmed, Canada (8lbs)	Atlantic farmed, Canada (5lbs)	Chinook troll, US (5lbs)
Preference Score	87.1	80.8	80.4	80	77.8	74.32	73.8	70	79.5
Price/Lb	\$4.00	\$4.50	\$5.00	\$5.50	\$5.00	\$3.50	\$4.50	\$4.50	\$2.50

TQ = Top quality (8+ day shelf life)
GQ = Good quality (5-7 day shelf life)

EXHIBIT 4.8: PREFERRED SALMON PRODUCTS IN GROCERY/SUPERMARKET SEGMENT

WINTER

PRODUCT	Atlantic farmed, Scotland (8lbs)	Coho farmed, US (5lbs)	Coho farmed, Canada
Preference Score	126	119.7	106
Price/Lb	\$5.00	\$4.00	\$4.50

SUMMER

PRODUCT	Atlantic farmed, Scotland (8lbs)	Coho farmed, US (5lbs)	Coho farmed, Canada (8lbs)	Coho troll-caught US (8lbs)	Coho troll-caught US (8lbs)	Coho troll-caught US (8lbs)
Preference Score	126	119.7	106	113.7	111.9	108.2
Price/Lb	\$5.00	\$4.00	\$4.50	\$3.50	\$3.00	\$3.50

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 80,000 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	7.99	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 farmed, 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. Nichiro, 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	<u>400</u>	<u>600</u>	<u>800</u>	<u>1,000</u>	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.

6.0 KEY MARKETING ISSUES AND PROBLEMS

A host of issues and problems are associated with marketing fresh seafood in North America, farmed salmon in particular. An understanding of these constraints is important in designing an effective marketing strategy for B.C. farmed salmon. For purposes of discussion, we have divided the issues into the following categories:

- . demand-related issues
- . market structure and coordination issues
- . supply-related issues.

These issues are summarized in Exhibit 6.1 and discussed in detail below.

6.1 Demand-related Issues

Low Level of Domestic (North American) Consumption of Seafood

Historically, North American consumption of fish and shellfish at the consumer level has been low compared to consumption of other meat products and with consumption in other countries.

In North America, Canada's per capita consumption is only slightly higher than that of the US. Major causes of this relatively low consumption, as determined from recent US National Marine Fisheries Service studies, include the following:

- . quality has been unreliable and inconsistent;
- . seafood is viewed as extremely perishable;
- . consumers are concerned about the possibility of food poisoning and think that fish has to be eaten the same day it is purchased;
- . consumers lack a general familiarity and competence in selecting, preparing, and cooking seafood;
- . many consumers have a negative association with fish

EXHIBIT 6.1: MARKETING ISSUES AND PROBLEMS FACING FARMED SALMON

Demand-Related Issues	Supply-Related Issues
. Low level of domestic (North American) consumption of seafood . Limited export opportunities for farmed salmon. . Few feasible product opportunities other than fresh sales.	. Existing structure of B.C. farming industry. . Variations in B.C. farmed salmon supply. . Lack of consistent production, harvest and post-harvest techniques. . Impact of increased imports from other supply areas.
Market Structure & Coordination Issues	
. Complex distribution channels. . Lack of adequate price/quantity information. . Traditionally weak price quality link in seafood marketplace. . Lack of uniform product standards and descriptions.	

because they were traditionally forced to eat fish during Lent and on Fridays.

Other reasons for the historically low consumption of seafood have been its lack of availability and the widespread availability of other sources of protein, such as meat and poultry. Compared to poultry, increases in per capita consumption of seafood have been sluggish. From 1976 to 1985, per capita consumption of all seafood has increased 12.4% (Exhibit 6.2). Meanwhile, the poultry industry has realized a 32.7% increase in per capita consumption in the same period (USDA, 1986). Red meat (beef, veal, pork, lamb, and mutton) and dairy product consumption have decreased in this nine-year period 6% and 15.7%, respectively (USDA, 1986).

TABLE 6.2: US ANNUAL PER CAPITA CONSUMPTION OF COMMERCIAL FISH AND SHELLFISH 1965-85 (LBS)

Year	Civilian Resident Population July 1 (Million Persons)	Per Capita Consumption			
		Fresh/ Frozen	Canned	Cured	Total
		 Pounds, edible meat			
1965	191.6	6.0	4.3	.5	10.8
1966	193.4	6.1	4.3	.5	10.9
1967	195.3	5.8	4.3	.5	10.6
1968	197.1	6.2	4.3	.5	11.0
1969	199.1	6.6	4.2	.4	11.2
1970	201.9	6.9	4.5	.4	11.8
1971	204.9	6.7	4.3	.5	11.5
1972	207.5	7.1	4.9	.5	12.5
1973	209.6	7.4	5.0	.4	12.8
1974	211.6	6.9	4.7	.5	12.1
1975	213.8	7.5	4.3	.4	12.2
1976	215.9	8.2	4.2	.5	12.9
1977	218.1	7.7	4.6	.4	12.7
1978	220.5	8.1	5.0	.3	13.4
1979	223.0	7.8	4.8	.4	13.0
1980	225.6	8.0	4.5	.3	12.8
1981	227.7	7.8	4.8	.3	12.9
1982	229.9	7.7	4.3	.3	12.3
1983	232.0	8.0	4.8	.3	13.1
1984	234.8	8.5	4.9	.3	13.7
1985	237.0	9.0	5.2	.3	14.5

Source: USDA, 1986.

Exhibit 6.3 presents consumer price indices for meat, poultry, dairy, and fish products for the period 1965 to 1985: fish prices increased 450%, poultry prices increased about 200%, meat prices 300%, and dairy product prices 300%.

EXHIBIT 6.3: CONSUMER PRICE INDICES FOR MEAT, POULTRY, DAIRY, AND FISH PRODUCTS, 1965-1985

Year	Meat	Poultry 1967=100	Dairy	Fish
1965	93.9	101.2	90.0	90.8
1966	102.6	106.7	95.8	96.7
1967	100.0	100.0	100.0	100.0
1968	102.3	103.1	103.1	101.6
1969	111.4	109.0	106.7	107.2
1970	117.6	108.4	111.8	118.0
1971	116.7	109.0	115.3	130.2
1972	129.2	110.4	117.1	141.9
1973	161.1	154.8	127.9	162.8
1974	164.1	146.9	151.9	187.7
1975	177.9	162.4	156.6	203.3
1976	178.2	155.7	169.3	227.3
1977	174.2	156.7	173.9	251.6
1978	206.8	172.9	185.6	276.4
1979	241.9	181.5	207.1	302.3
1980	248.8	190.8	227.4	330.2
1981	257.8	198.6	243.6	357.7
1982	270.3	195.1	247.0	370.6
1983	267.2	197.5	250.0	374.9
1984	268.1	218.5	253.2	386.8
1985	261.2	216.4	258.0	407.9

Source: USDA.

Despite the problems associated with lack of consumer knowledge about seafood and the relatively high increases in prices, demand for seafood is increasing. Some market analysts argue that the fact that real prices for seafood have been steadily rising indicates that demand for seafood is strong. Insufficient supply of quality product explains both higher prices and low consumption levels. As shown in Exhibit 6.2, record consumption of fresh/frozen seafood was achieved in 1985. Nearly all of the growth in seafood consumption has been in a fresh/frozen form. This has

important significance for the B.C. salmon farming industry since an increase in consumption of one salmon meal per year per person would result in increased consumption of nearly 57,000 tonnes.

Much of the decline in red meat consumption and increases in poultry and seafood consumption is attributed to the American consumer's increased awareness of diet and health and to the recent medical research linking the high levels of fat and cholesterol found in red meat to heart disease, the number one cause of death in North America. According to recent studies published in the New England Journal of Medicine, fish and shellfish, unlike red meats and poultry, contain substances called Omega-3 polyunsaturated fatty acids. These fatty acids appear to reduce the risk of contracting coronary heart disease, and act to remove the conditions which cause the disease.

The increase in consumption of seafood can also be isolated by demographic group. The most recent NMFS survey revealed the following:

- . Income is positively correlated with fresh finfish consumption, and income and education have become important variables in determining seafood consumption. The top income group consumes seven times more fresh finfish than the lowest income group.
- . 80% of seafood consumers are aged 24 to 64 years.
- . About one-half of all finfish is consumed by people in cities with populations greater than 1 million.
- . Most away-from-home consumption occurs in urban areas of the east coast, west coast, and Great Lakes regions.

These demographic findings indicate that large untapped markets exist within lower income groups, under 25 and over 65 age groups, in nonurban areas, and in the central US. However, the groups most likely to increase their consumption are those groups that in 1981 were already consuming relatively large amounts of seafood.

The key to increasing fish consumption lies in effective promotion to, and education of, the consuming public. This will be one of the critical marketing challenges facing the fresh seafood industry. However, promotion must also be backed up by availability.

Limited Export Opportunities for Farmed Salmon

As previously indicated, Japan and Europe represent the largest markets for salmon. However, because of increased supplies of farmed salmon in Europe, primarily from Norway and Scotland, and transportation disadvantages vis a vis European producers, B.C. farmed salmon is unlikely to penetrate these markets profitably during the next three to five years.

Japan does offer some limited potential for B.C. producers:

- . Established trading links for salmon between B.C. and Japan already exist.
- . Coho is being successfully farmed in Japan and the demand for fresh farmed coho is expanding.

To identify a window of opportunity for B.C. farmed salmon in Japan, we reviewed previous studies on the farmed coho industry in Japan and conducted interviews with major Japanese trading companies in Vancouver. Our findings are described below.

Japanese coho farming began in 1976 and produced almost 7,000 tonnes in 1985. The farming area is confined to the fjord type beach area of Miyagi prep, which accounts for more than 95% of production. Approximately 250 farmers are engaged in marine farming operations and approximately 90 farmers in freshwater (hatcheries and seeds) operations. Eyed eggs are imported from Washington and Oregon. The industry is highly vertically integrated and is controlled by three companies: Nichiro Fisheries, Targo Fisheries, and Nichimo Co. Ltd. (the largest fishing gear company in Japan). These three companies account for more than 90% of the coho farming

industry from production (including financing farmers) to final marketing.

Future growth in the industry will be constrained by the following factors:

- . A limited area of coastline in Japan is suitable for salmon farming; production is confined almost entirely to an area near the northeastern tip of Honshu.
- . The egg supply is uncertain. Currently, eggs are obtained from hatcheries in Washington and Oregon.
- . Warm summer temperatures necessitate harvesting within a short period and restrict availability. This also has resulted in wide fluctuations in pricing and has made brood stock development difficult.

As a result of these factors, Japanese farmed coho production may not increase beyond 15,000-20,000 tonnes annually.

The short season and limited production domestic capability may mean an opportunity for significant sales of B.C. farmed salmon to Japan. Our findings from interviews with the Japanese trading companies are summarized below.

- . Japanese consumers are very quality and price conscious. They prefer sockeye because of the deep red flesh colour. Consumers generally only switch to coho when the price of sockeye is very high. For example, a shortage of sockeye in 1986 resulted in strong sales of frozen wild coho from B.C.
- . The demand for fresh salmon in Japan is increasing only gradually. This partially explains the limited penetration obtained by the Norwegians in Japan.

- . One major trading house has sent samples of B.C. farmed coho and chinook to Japan. The products were considered equal or superior to Japanese farmed coho. However, there is still considerable experimentation being undertaken with the products such as smoking and in ~~sushi~~ sushi. Sampling is likely to continue.
- . The Japanese trading companies still view the B.C. salmon farming industry with skepticism. Until quality and consistency of supply can be assured, they are not likely to be willing to purchase substantial quantities.

In summary, relatively few opportunities exist to export significant quantities of B.C. farmed salmon out of North America in the short term. In addition, export sales to Japan are likely to be restricted during the winter months, when supplies of Japanese farmed coho are unavailable. In contrast to North America, the challenge in Japan is to induce consumers to switch to farmed coho and chinook from other salmon species and other seafoods.

Few Feasible Product Opportunities Other than Fresh Sales

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 in a fresh, frozen, or higher value-added processed form (e.g., smoked,

pate product). The market opportunities in each of these areas are briefly discussed below.

Fresh product that does not meet superior grade specifications may be perfectly acceptable in many fresh markets. An unbled fish may be perfectly acceptable if the distributor plans to move it quickly and maximum shelflife is not a requirement. A scarred fish exterior or extensive scale loss may be acceptable if the fish is going to be steaked or filleted. What constitutes "lower grade" fish, and its subsequent marketability in fresh form, will be a function of the grading standards adopted.

Fresh fish that is damaged due to poor handling and cleaning may be marketed in a cut form (rather than whole) without much loss of value. Fish downgraded for any significant reason that affects its freshness or shelflife may have to be sold in local domestic markets where it can be moved quickly.

Freezing may be an option for lower grade fish. It also may be a necessity during periods of short term fresh market gluts. In some markets, such as Japan, freezing might be an option for enhancing product value. Freezing fish basically prolongs shelflife and may be an acceptable short run alternative if the frozen price less the associated freezing costs exceeds the available fresh price. This is an unlikely long term option unless farm production costs are substantially lowered. Frozen market prices will be determined by the lower cost of wild product and these prices would not yield sufficient net returns to the farmer.

An exception to this might be the use of advanced freezing technologies immediately after harvest to produce a top-quality frozen fish. Fish that is frozen correctly immediately after harvest at the peak of flavour, then properly stored and thawed can produce a product close to fresh fish in quality. On the other hand, fresh fish that is frozen at a later date because of handling or processing

delays, or a glut of fresh fish on the market, is of completely different quality.

The problem in North American and traditional export markets is that these two types of fish are sold at the same price. There has traditionally been a weak quality/price relationship, with little incentive to produce a superior product.

This will affect any efforts to freeze farmed fish and sell it in North American markets. A higher quality farmed product will be difficult to distinguish from the vast quantities of wild product and hence may not receive price premiums. Existing markets for such a frozen salmon product are small and selective, and may be difficult to access using normal processing and distribution channels.

Some industry participants in B.C. and abroad suggest the production of higher-valued processed product might be a viable option for lower grade farmed product, such as smoked salmon sides, salmon pates, and ready-prepared dishes.

Smoked salmon sides are not a realistic product option for lower grade salmon that have excessive internal flesh damage or poor colour. In fact, the cleanly bled carcasses and lack of bruising associated with farmed salmon have made Norwegian Atlantics very popular in European smoking markets. Other advantages such as less waste, lower inventory financing costs (i.e., buying fresh product when it is needed), and more stable prices have led to increasing substitution of farmed for frozen Pacific species in markets such as the U.K. and France.

For cost reasons, it is unlikely that fresh B.C. farmed salmon could compete effectively in European markets with its Norwegian counterpart. As well, the North American smoked market is not nearly as large as Europe's. We estimate its current size to be about 6,000 tonnes. Smoking facilities

are concentrated close to large urban centres (e.g., the Eastern U.S.). Chinooks have traditionally been the premium smoking species, with a recent upsurge in the use of sockeye. Coho is also important in the smoking trade.

Size, flesh colour, price, and taste are critical purchase criteria for smokers. They prefer larger fish (9+ lbs). B.C. farmed production is not expected to be in this size category initially, although chinooks show some promise. Best results would be obtained if flesh colour could be enhanced to a sockeye-equivalent. This would give it an advantage over paler Norwegian Atlantics. If chinook can be grown out to a large size and good colour obtained, local smokers feel the traditional European market for large red chinook sides might be a possibility. They have suffered from declining wild fish supplies in recent years.

The flavour of farmed salmon is somewhat blander than the wild fish equivalent, according to local smokers. Specific smoked fish markets are known to be very particular in taste and texture requirements. The farmed fish would be perceived as different by both smokers and their customers, and there may be a need to develop a specialized niche for the product.

The prime competitive source of supply for smoking markets will be frozen Pacific chinook and coho. As a result, price will be a critical consideration. Higher prices for the farmed product will not materialize unless colour and size requirements are met, the market for smoked product improves, and lower inventory financing costs produce real savings for smokers.

It is likely that farmed salmon could initially augment the supply of wild Pacific chinooks, especially if wild shortages occur. Because the larger fresh chinooks are also highly marketable to the HRI trade, it is not clear that smoking markets would provide as good net returns.

In summary, smoking does not appear to be a significant market option for B.C. farmed salmon production in the near term.

Other value-added processed items such as smoked salmon pate are being assessed by local B.C. producers. One producer interviewed indicated some interest by local retail chains in a sample of smoked pate. Farmed salmon would be an expensive alternative source of raw material to the wild product, especially compared to species such as chums and pinks.

6.2 Market Structure and Coordination Issues

Many marketing problems evolve from the manner in which the seafood industry is organized and the way sales and sales information is handled. It is the function of the marketing system to coordinate the production decisions of producers with the purchase decisions of consumers. This coordinating role is generally played by middlemen within the distribution network. The complex distribution network, the lack of adequate price and quantity information, a traditionally weak price/quality link in the marketplace, and lack of uniform product standards and descriptions are all potential sources of marketing problems.

Complex Distribution Channels

The following paragraphs describe various distribution channels for fresh and frozen salmon and the roles played by the various participants.

Selected variations in distribution channels for fresh and frozen salmon are shown in Exhibit 6.4. Distribution varies in complexity and length: from direct selling by producers to consumers (A) and restaurants or retailers (B) to overseas export sales which involve several middlemen. (Since there are few import restrictions on exports of B.C. salmon to the U.S., the U.S. is considered a domestic market.) The principal

including frozen fish. Fresh fish is most often marketed through specialty seafood distributors. Similarly, sales of fresh fish through brokers account for a relatively small proportion of the market's volume. Brokers play a larger role in frozen markets where there is more bulk selling and production can be inventoried for long periods. The balance is sold direct by producers or processors to buyers in the food service or retail segments. Significantly, the integrated processor with its own marketing capability and sales force rarely sells directly to those segments. Also, it is generally not a major factor in fresh fish markets.

With overseas markets, the distribution chain can be quite long. However, a strong supplier-customer relationship can lead to a shortened distribution channel. For example, Jimmy's seafood restaurant in Boston and the Hilton hotels in New York purchase Norwegian salmon and deal with an importer, by-passing the wholesaler.

The role of the middlemen in the principal channels of distribution is further discussed in Appendix E. Typical pricing and margin levels at each point in the distribution channel are also provided.

Problems associated with the distribution channels described above relate mostly to loss of control over quality once products are shipped to processors and/or markets, particularly with increased changes in physical possession and ownership. In other words, with a longer chain, quality deterioration is more likely. Some examples of several weak points in the chain are described below.

Many producers and transport companies are unaccustomed to handling fresh fish. Sometimes fresh fish is transported in trucks or planes without refrigeration. Some airports do not have adequate holding facilities for fresh fish. Delayed or cancelled flights and missed connections can also affect shipments of farmed salmon. To avoid problems with melted ice leaking from packaging, many North American carriers

allow the use of gelpacks, which are not as effective as properly packed wet ice in preserving the shelflife of fish.

Lack of Adequate Price/Quantity Information

Prices reflect supply and demand at the final market level. These prices must be passed down through the market system in order for salmon farmers to know which products to supply in what quantities. Certain desirable attributes of price information are often lacking in the present seafood marketing system, including the marketing of farmed salmon.

Generally, the basic problems are the lack of a formal price reporting system at the retail level and only a limited reporting system at the wholesale level. Limited price information is published for selected wholesale markets such as the Fulton Fish Market in New York. However, these are usually one or more levels removed from the producer. This often leads to incorrect information in terms of the size of marketing margins and expected gate prices.

Our analysis of historical prices for farmed salmon sold in the U.S. clearly indicates that Norway is the leader in terms of setting prices of farmed salmon. From our discussions with producers and from analyses of selling prices of B.C. farmed salmon in 1985, we determined that B.C. producers have been obtaining prices equal to, or slightly below, those paid for Norwegian product. However, producers and processors reported difficulties in determining appropriate selling prices for their product. These difficulties included:

- . prices quoted in the newsletters are averages only;
- . prices quoted are also dependent on the volumes being sold, which is sometimes difficult to determine, and;
- . selling prices in centres other than those for which regular wholesale prices are published must consider transportation costs and additional selling costs from those centres. Often these selling costs can only be estimated.

The lack of reliable price information also poses difficulties in assessing the costs and benefits of harvesting salmon at certain sizes, as there are considerable price breaks between size categories. Average wholesale prices of Norwegian Atlantic salmon for various size categories in 1985 and 1986 are shown in Exhibit 6.5.

As indicated in the exhibit, a considerable price break exists between the 2-3 kg. and 3-4 kg. size categories. Above 3-4 kg., the price break diminishes. The B.C. producer may be faced with a decision to sell chinook during the second winter in seapens at 2-3 kg. or hold production over until the following autumn and harvest at 3-4 kg. Without accurate price data, this decision is made more difficult.

EXHIBIT 6.5: AVERAGE PRICE DIFFERENCE OF NORWEGIAN ATLANTIC SALMON BY SIZE CATEGORY IN 1985-86^a (US\$/kg)

	I 2-3 kg	II 3-4 kg	III 4-5 kg	IV 5-6 kg
Average Price	\$8.56	\$9.39	\$9.75	\$9.88
Difference Between Categories	.83	.36	.13	

^a Wholesale prices are CIF New York

Source: Urner-Barry Seafood Price Lists (various)

Lack of Strong Price/Quality Relationship

The North American processing and distribution system for seafood traditionally has not been able to recognize and reward quality in fresh and frozen seafood. Numerous factors contribute to weak price/quality links at all levels in the production and distribution cycle. Traditional harvesting methods are generally not geared to producing a top quality, long shelf life product for fresh or frozen consumption. Processors have been unable to economically separate top quality and lower quality fish. The same applies to other

links in the distribution and selling chain. As a result, average prices are the critical selling factor, and very little quality differentiation exists. The inability of the traditional processing and distribution system to recognize and reward quality in the form of premium prices is the key reason why quality improvement programs in the traditional fishery are usually unsuccessful. This has important implications for farmed salmon marketing.

The viability of the B.C. farmed salmon industry is clearly dependent on the market paying premium prices for quality, which dictates a strong price/quality link. The success of Norwegian salmon in the U.S. shows that this can be done. However, a significant portion of the North American seafood distribution system is still not accustomed to handling a high quality, fresh product. This means that some brokers and wholesalers will want to treat farmed salmon solely on the basis of price. A grading system that communicates consistent, reliable information is important to building a strong price/quality relationship in the North American marketplace.

Lack of Uniform Product Standards and Descriptions

In addition to price information, the proper communication of demand and supply conditions in the marketplace requires the use of precise language for grades and standards, which are not as widely standardized in the seafood industry as they are for other food commodities. This leads to product mislabelling, communication problems, and difficulties in achieving better prices for higher quality product.

At present, a grading system specific to farmed salmon in B.C. does not exist (unlike Norway, whose exports are restricted by the government to top quality product). B.C. exports of farmed chinook and coho to the U.S. need only be "wholesome". As a result, informal grades which apply to the wild fishery are loosely applied to farmed chinook and coho.

Also, unlike exports for sockeye, the grading of chinook and coho is not regulated by government inspectors. Furthermore, differing production and harvest methods employed in pen-raised salmon may mean that these grade standards are not entirely applicable. The marketplace may require information about farmed salmon products which may not be contained in the description of grades in the wild fishery. Moreover, in the absence of a grading system unique to farmed salmon, the marketplace may not pay premiums for certain quality attributes that make farmed salmon superior to its wild counterpart.

6.3 Supply-related Issues

Many of the marketing problems discussed above are magnified by supply-related problems.

Industry Organization and Structure

An industry's structural characteristics generally refer to the number and relative size of firms at different market levels and the vertical integration between market levels. Surveys of producers and processors determined the following structural characteristics of the B.C. salmon farming industry relevant to distribution and marketing:

- . A few large producers are either currently or projected to be integrated to the point of including smolt production, grow-out sites, processing and marketing within a single operation. A recent study conducted by the DPA Group Inc. estimated that 12% of the farms would produce nearly 60% of total industry output. In addition, many of these large farms have investment from large Norwegian companies which already have marketing links to North America.
- . Contract farming arrangements are being established with large processors in the traditional fishery.

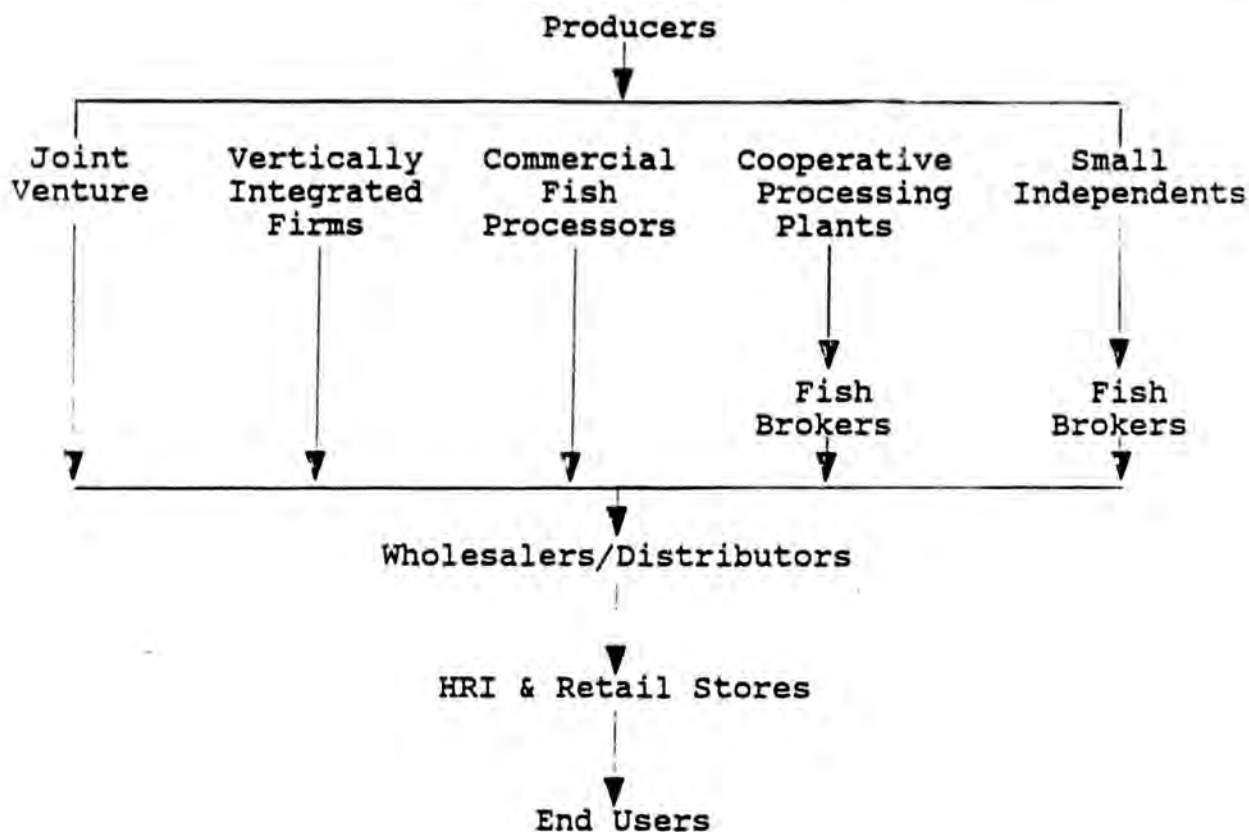
- . Processors in the traditional fishery are purchasing product outright or are offering custom processing and brokerage services.
- . Some producers are establishing cooperatively owned processing plants; through these plants, joint marketing may also be initiated.
- . Some smaller independent producers are having their production custom processed and selling through fish brokers.
- . Joint venture arrangements are being considered among producer groups, processors, and seafood sales organizations. These arrangements would produce large selling organizations for the purpose of marketing large, stable supplies of salmon to retail markets.

A number of institutional arrangements are emerging for the purpose of marketing and distributing salmon. The major options open to producers are illustrated in Exhibit 6.6. The advantages and disadvantages of each are discussed below.

The independent option calls for individual producers to take responsibility for selling their product to fish brokers, or possibly directly to large wholesalers. Most of the marketing and selling function would be handled by the producer. The fish would be either custom processed or processed within the independent's own facility.

The main advantage of such a system would be the amount of control the independent would exercise over marketing of the product. The disadvantages relate to the probable small scale of operation. Significant economies of scale in marketing are difficult to achieve by small producers acting alone. The marketing and selling function can involve significant fixed costs (e.g., sales force, advertising costs, billing and

EXHIBIT 6.6: MAIN DISTRIBUTION OPTIONS FOR B.C. SALMON PRODUCERS



collections costs). The higher the sales volume, the lower the unit selling costs. A larger scale marketing operation can provide:

- access to a larger, more continuous, stable source of supply (brokerage fees and selling prices are often a direct function of sales volume. Small, inconsistent supplies of product often involve higher brokerage fees and lower prices for the producers);
- greater cost-effectiveness in advertising, promotion, and gathering market intelligence;
- more negotiating power with brokers, wholesalers, and other parts of the distribution chain.

Some producers are establishing cooperative processing plants, and/or joint marketing arrangements. This could involve, for example, a group of producers arranging a contract with a common broker. The main advantage of this arrangement over the independent option is potentially lower processing and selling costs due to the larger scale of operation. The disadvantages relate to additional coordination and cooperation needed in a group selling effort.

Producers also have the option of either selling fish outright to established processors or to retain the processor as a sales agent on a commission basis. In both cases, the processors will sell through their established network of contacts in the seafood distribution business.

The advantage of this option is that the marketing and selling functions are left with firms with established relationships with credible, reputable wholesalers/distributors. They are familiar with all the requirements for marketing fish, although they may not have extensive involvement in fresh salmon marketing. The disadvantages relate to the loss of control over the product and its marketing. Also traditional processors may view salmon as an add-on to their marketing of other seafood products such as canned and frozen items, which may not be compatible with fresh selling.

A similar option exists for smaller producers to sell to a number of larger, vertically integrated producers that have recently emerged in the B.C. aquaculture business. These are normally well capitalized operations that employ full-time marketing and sales staff. The advantages and disadvantages of this arrangement are similar to marketing via established processors. An additional advantage might be that the larger aquaculture firms might be more aware of the requirements of effectively marketing fresh farmed salmon.

Joint venture arrangements are being discussed by participants in the B.C. industry. Such ventures would bring together any number of producers, processors, and seafood sales organizations and would involve some form of joint ownership.

In theory, such joint venture arrangements offer producers joint ownership, control, and participation in the marketing function along with processors and/or sales organizations. As such, they allow producers to share in the profits (and potential losses) associated with the processing of the farmed product.

These large institutions should be able to take advantage of the scale economies associated with marketing and selling. Such joint venture arrangements are beginning to emerge in Norway, combining various groups of exporters, producers and processors. Some view them as a necessary development in order to accumulate the necessary technical expertise, capital, and supply capabilities to market effectively in the future, especially to retail chain store markets.

The disadvantages of these arrangements lie primarily with the amount of negotiating effort required to reach and maintain an agreement that balances the interests of all parties.

All of the above options offer advantages and disadvantages to individual producers. However, definite economies of scale exist in the marketing and selling functions. To maximize net returns, independent producers will have to look seriously at some form of cooperative selling arrangements or aligning themselves with established firms in the industry. This is further discussed in Section 10.

Variations in B.C. Farmed Salmon Supply

The majority of farms recently established in B.C. have not

yet matured: many farms will not achieve production until 1988. In addition, the industry will continue to rely primarily on the supply of wild eggs from federal government hatcheries. As a result, in the short term the industry will face some problems similar to those faced by the commercial fishery. These include the following:

- . timing of supply: because of early maturation, some production will be harvested during the wild season;
- . inventory control: uncertain estimates of the number and size of fish renders the filling of orders for specific quantities and sizes more difficult;
- . inconsistency of supply: relatively small scale production hampers consistent supply.

These problems and their implications are discussed below.

Proper production planning and scheduling is critically important. Production scheduling refers to controlling and coordinating the supply of fish to the marketplace in order to maximize sales volume, market share, and prices. In theory, one of the most important advantages farmed salmon enjoys over wild salmon is control of harvest time. Furthermore, the potential exists for producers to have a continuous year-round supply of product available which can have real marketing advantages.

In reality, very few producing groups in the world have achieved full continuity of supply throughout the year. Continuous supply is basically at odds with natural fish biology. Techniques such as sterilization and use of controlled rearing environments are being used to prevent or delay the onset of sexual maturity in fish. However, the methods are far from proven and some techniques, such as the use of hormones for sterilization, raise serious marketing concerns for the industry.

Within the B.C. industry, early maturation problems and financial constraints are forcing producers into less than

optimal selling patterns. Early maturing fish result in a seasonal production, little supply continuity, and a requirement to sell quickly before declines in quality set in. Similarly, cash flow constraints are causing producers to sell small-sized fish for lower than optimum prices.

These problems will be overcome in the longer term, but they have important implications for industry and individual firm strategies in the short term.

Lack of Consistent Production, Harvest and Post-Harvest Techniques

Differing production, harvest and post-harvest practices among producers also can cause supply-related problems. The unrestricted use of hormones and drugs in the industry by some producers may result in consumer backlash and even import bans.

Some aspects of quality, such as external appearance, can be graded. But other important aspects of quality cannot be easily measured by graders: fat content, colour retention and shelf life. As a result, quality may not be uniform.

Pre-harvest and harvest techniques also differ significantly. Starving and on-site bleeding as practised in Norway are being more widely practiced in other countries. In Canada, regulations are not yet in place regarding the disposal of blood. Hauling live fish or bled fish to a processor at present involves several methods, which are not governed by guidelines or regulations.

Packaging is not consistent within the industry, and the amount of wet ice, dry ice or gel packs used varies considerably.

Handling of boxed fish through the distribution chain is not well controlled. As a result, problems arise when boxed fish

is left out on loading docks at airports or shipped in unrefrigerated trucks. As a result, shelf life is reduced or fish may even spoil.

All of these problems point to the need for industry-wide quality assurance guidelines and standardization.

Impact of Increased Imports from Other Supply Areas

Increasing imports of farmed salmon into the U.S. from areas such as Norway and Chile is a crucial factor in the future viability of the B.C. industry. However, an indication of the impact of increased imports on prices can be obtained from an analysis of recent selling prices of Norwegian salmon in the U.S. Average wholesale prices by size category of Norwegian Atlantic salmon in 1985 and 1986 is shown in Exhibit 6.7.

**EXHIBIT 6.7: AVERAGE PRICE OF NORWEGIAN ATLANTIC SALMON
(US \$/kg)**

	2-3 kg	3-4 kg	4-5 kg	5-6 kg
1985	8.67	9.86	10.30	10.41
1986	8.47	8.98	9.24	9.41
% change 85-86	-2%	-9%	-10%	-9%

Source: Urner-Barry Seafood price lists (various)

As indicated, prices have fallen in each size category. This may be attributable to many factors, including increased competition amongst Norwegian exporters, increased supplies from other regions and fluctuating exchange rates. The downward trend in prices is likely to continue as significant volumes from other competing regions are introduced. The extent to which wholesale prices will decline during the next five years will critically affect not only the financial returns to producers, but also the marketing of B.C. farmed salmon. Uncertainty about prices may result in producers

being overly optimistic in their business plans which, in turn, could cause financial failure.

Farmed salmon generally sell for higher prices than their wild counterparts in North America. However, premiums may not continue unless efforts are made to promote the attributes perceived to make farmed salmon a superior product.

7.0 PRODUCT POSITIONING AND TARGET MARKET IDENTIFICATION

This section examines the B.C. salmon farming industry's competitive advantages and disadvantages vis a vis other supply regions in order to determine an appropriate positioning of the B.C. product and identify target markets.

7.1 Competitive Advantages

B.C.'s main advantages in the North American marketplace are:

- . preferences for chinook and coho;
- . transportation advantages;
- . good growing conditions;
- . strong positive image of B.C. salmon;
- . stable exchange rates vis a vis the U.S. dollar.

Species Preference

Anderson's conjoint analysis addressed the issue of preference of Pacific vs Atlantic salmon in the specific U.S. market segments. The results are described in Section 3.0. To summarize, the main findings were:

- . Chinook salmon is significantly preferred to all other species for expensive seafood restaurants and marginally preferred in fish stores.
- . Coho salmon is slightly preferred (over Atlantic) by inexpensive non-seafood restaurants and grocery/supermarkets.

These findings are also supported by other recent studies (FERENCE, 1986; Woods Gordon, 1983).

These results suggest that B.C. farmed salmon could compete effectively against farmed Atlantic salmon in most market segments, provided it matched or exceeded Norwegian producers

in providing other significant attributes (e.g., product form, size, quality).

Transportation Advantages

The following exhibit indicates transportation costs for farmed salmon from competing regions to various U.S. centres. In the exhibit the rates are taken from various rate schedules which show shipments at differing quantity levels. Also most shipments are usually in LD3 containers, which hold a maximum of 3,164 pounds (gross weight), and which are not shown in most rate schedules. As a result, rates are only indicative of differences in freight costs. In addition, containers are assumed to use the same amount of ice or gel pack in order to isolate differences in freight costs.

EXHIBIT 7.1: AIR FREIGHT COSTS/KG* FOR FARMED SALMON (US\$)

	B.C. ¹	Norway ²	Chile ⁴
Los Angeles	.25 (.10) ³	2.53	1.68
Chicago	.80	2.05	N/A
New York	1.05	1.75	N/A

¹ Western and United rates are based on shipments of 1,000 lbs; shipments to Chicago and New York are assumed to be first trucked to Seattle.

² SAS rates are for shipments of 1,000 kg.

³ Brown Line truck rates are based on shipments of 25,000 lbs.

⁴ CP rates are based on shipments of 500 kg.

As the exhibit indicates, B.C. has a substantial freight advantage over Norway and Chile for shipments to the west coast of the U.S. B.C. has fewer freight advantages to Chicago and New York.

The closer proximity to west coast markets also confers other advantages, including shorter delivery times and no major

differences in time zones. Also, language and cultural barriers are non-existent or minor. Consumers might also positively associate the close proximity of B.C. with increased product freshness.

Growing Conditions

B.C.'s coastline offers better growing conditions than most other producing areas. Warm winter sea temperatures, protected and pollution-free waters should, in the long term, result in production advantages.

Strong Positive Image of B.C. Salmon

B.C.'s wild salmon products are generally positioned at the high end of the marketplace. Harvesting and processing techniques are better than those practised by U.S. counterparts because of stricter quality control regulations, government regulation of standards, and government restrictions on methods of catch. As a result, salmon fishermen in B.C. have historically obtained higher prices. Frozen B.C. salmon also tends to receive higher prices in European markets than its Alaskan counterpart.

The strong positive image already associated with the salmon could help the B.C. salmon farming industry's marketing efforts.

The positive impact of Expo and the strong image of B.C. as a world-class salmon sport fishing area also could contribute to a positive image, especially in the eyes of western U.S. residents.

Stability of Exchange Rates

The Canadian dollar is a stable currency. Also, the dollar is not subject to erratic fluctuations vis a vis the U.S. dollar. As a result, stable export prices can be maintained

without significant changes in returns to producers. This is in sharp contrast to Norway where a recent reversal of the rising value of the U.S. dollar against European currencies has meant lower returns to Norwegian producers.

7.2 Competitive Disadvantages

B.C.'s main disadvantages in the North American marketplace are:

- . high costs of production;
- . lack of a marketing focus.

Both of these disadvantages which stem mostly from the relative newness of the industry, are discussed below.

High Costs

The B.C. industry, in relation to other producing areas, has both high capital and operating costs. Most of the major equipment installed is imported from Norway and is designed for rougher sea conditions. As a result, the industry may be more capital intensive than necessary and certainly more capital intensive than some other producing regions. A lack of low-cost transportation infrastructure in many areas makes distribution of inputs and final products more expensive.

Of domesticated brood stocks, low survival rates, low conversion and other bio-technical constraints also contribute to higher costs. Biotechnical constraints not only contribute to higher costs of production but to the inability to produce fish in sizes most demanded by various segments, which results in lower returns. In addition, most large farms have not yet reached full production. Overall production is not yet fully efficient.

Lack of a Marketing Focus

To date the industry has been mostly production driven. A lack of emphasis on marketing has meant that other producing areas have marketing advantages over the B.C. industry.

Marketing deficiencies faced by the B.C. industry relative to a major competitor, such as Norway, are:

- . lack of grading and quality assurance standards
- . inconsistency of supply and small scale selling
- . lack of industry-wide promotion programs
- . lack of an integrated industry-wide marketing strategy.

The problems associated with these marketing issues were discussed in Section 6.0. These deficiencies must be overcome before the B.C. industry will be able to compete successfully at the high end of the market.

7.3 Product Positioning

This section addresses image and positioning for B.C. product in the marketplace.

The establishment of major feed facilities by European manufacturers, the establishment of extension and diagnostic services, and increased government support in research should improve the viability of the industry during the next five years. However, the development of domesticated strains of chinook and coho, which has begun, is not likely to result in major gains in improved survival and growth for some time. As a result, the industry will be faced with relatively high costs of production during the next five years. It is possible that initial high costs of production could eliminate much of the competitive advantage B.C. enjoys with respect to freight.

However, high costs should not prevent the industry from producing high quality fish. According to processors interviewed in the industry, a very high percentage of recent production processed was of a quality equivalent to the Norwegian superior grade.

The positioning of B.C. product should therefore be based on quality and other non-price attributes of the product, rather

than on price competitiveness. A third factor which supports the argument for not competing on the basis of price is that there is considerable unfulfilled demand in North America, as discussed in Section 5.0.

Furthermore, the Anderson, Ference, and Woods Gordon studies clearly indicate that none of the competing regions, including Norway, has entrenched positions in the North American marketplace. One of the main reasons for this is that none of the competition has yet to promote heavily in the U.S. Norway has promoted the most but has mostly restricted its promotion efforts to attending trade shows and obtaining distribution with wholesalers. Very little promotion at the retail and consumer level has been undertaken; as a result, consumer awareness of competing products is low.

In terms of image, the focus should be on creating a perception in the marketplace that B.C. produces the best salmon i.e., the salmon capital of the world. Therefore, fresh Pacific salmon must be the best. At the consumer level, a "best" image position has not been promoted by competitor areas. British Columbia, with its clear, cool waters, long coastline, natural beauty and popularity of sport fishing would easily justify a "best" positioning. In the end analysis, B.C. salmon sold in the marketplace may or may not be of better quality than that from competing regions. However, if a market perception is developed that B.C. is the best area in the world for salmon, then the image of better quality fish can follow naturally. If established in the market through a marketing support program, this positioning could establish the industry in a very competitive light. It would also steer a marketing path away from direct price competition which is necessary to support the industry's high cost structure.

7.4 Target Markets

Section 3.0 presents a breakdown of demand for fresh and frozen salmon in North America by region. In the US, the majority of demand is concentrated in the mid-Atlantic, South Atlantic, and Pacific regions. In Canada, the majority of demand is concentrated in Ontario and Quebec.

We examined four factors to identify the most promising target markets for B.C. salmon:

- . regional differences in wholesale prices and freight costs,
- . current size and expected growth in salmon consumption by region,
- . regional economic and demographic factors, and
- . non-tariff barriers. .

These factors are analyzed below.

Regional Differences in Prices and Freight Costs

As previously indicated, California is the largest, most immediate market for B.C. producers. In addition, B.C. enjoys a considerable freight advantage over other producing regions to this state. In the absence of other competing factors, the difference in prices of Norwegian salmon in the US Eastern Seaboard and California markets should simply be additional freight costs. In reality, this is not the case. The freight differential to the Eastern Seaboard and California is approximately \$.75 per kg. The following table compares differences in price for Norwegian salmon in the Eastern Seaboard and California in 1984 and 1985.

As indicated in Exhibit 7.2, some or all of the freight difference is being absorbed by Norwegians on sales to California. In fact, 1985 average L.A. prices are very close to New York prices. The difference may partly result from the mix of sizes shipped to each centre. The small price

difference may also be due to the availability of large volumes of West Coast salmon, imports of fresh salmon from Chile and New Zealand, and competition from other species of fresh fish, such as orange roughy and red snapper. The lower prices net of transportation costs obtained in California explain why over three-quarters of all Norwegian imports are sold in the New York and Boston areas.

TABLE 7.2: AVERAGE PRICE/KG OF NORWEGIAN SALMON

	1984	1985
Eastern Seaboard		
New York	\$ 9.27	\$9.19
Boston	\$ 8.72	\$9.27
California		
Los Angeles	\$ 9.70	\$9.26
San Francisco	\$10.52	\$9.92

Source: National Marine Fisheries Service. (Airfreight costs have been added to declared values)

The difference in freight costs between shipping farmed salmon from B.C. to California and New York or Boston is approximately \$1.00/kg. by truck and \$.75/kg. by air. This suggests that B.C. producers could obtain higher returns by selling in California than on the Eastern U.S. coast.

Current Size and Expected Growth by Region

Another significant factor in determining target markets is the current size and expected growth in salmon consumption in each region. The growth potential in tonnes by region is shown in Table 7.3.

As indicated in the exhibit, the areas with the highest growth potential are those that currently consume the most fresh/frozen salmon. Areas such as the Pacific and the Mid Atlantic regions could absorb all of the projected B.C. production to 1990. Also, Canadian markets could absorb over 70% of projected production in 1990.

EXHIBIT 7.3: CURRENT AND POTENTIAL DEMAND FOR FRESH/FROZEN SALMON -- US REGIONS (TONNES)

Region	Current Demand	Potential Demand	Growth
US			
New England	8,200	12,400	4,200
Mid Atlantic	17,300	26,800	9,500
NE Central	7,700	12,000	4,300
NW Central	1,600	2,600	1,000
SO Atlantic	12,000	18,900	6,900
SE Central	4,800	7,600	2,800
SW Central	4,700	7,600	2,900
Mountain	1,100	1,800	700
Pacific	<u>15,300</u>	<u>23,200</u>	<u>7,900</u>
	72,800	113,000	40,200
Canada			
B.C.	1,500	2,400	900
Prairies	2,400	3,700	1,700
Ontario	4,800	7,600	2,800
Quebec	3,500	5,500	3,000
Maritimes	<u>1,200</u>	<u>1,800</u>	<u>600</u>
	13,500	21,100	7,600

Source: The DPA Group Inc. and J. Anderson, 1986.

Regional Economic and Demographic Factors

In recent months, prices for salmon in the Mid Atlantic and New England areas have been very strong. A bouyant economy in these areas has resulted in rising per capita incomes and a corresponding increase in demand for seafood. Demand for salmon has also increased because of low supplies of other species of fresh fish.

Shifts in population can also affect demand for seafood. For several years, the population of the South Atlantic region has been rising faster than any other region.

Shifts in regional economic conditions can affect the choice of target markets. The current bouyant economy on the US Eastern Seaboard and supply shortages make it an attractive market outlet for B.C. salmon, even though we could compete more effectively on the U.S. West Coast, given freight advantages.

B.C. has high per capita consumption and is a relatively mature salmon market. However, prices for farmed salmon in B.C. tend to be lower than those of other areas because too many producers try and sell product at the same time and bypass wholesalers and/or offer the same selling price to wholesalers as to retailers. As a result, the B.C. market will not likely represent a viable target market over the long term but may represent a relatively inexpensive test market.

Non-Tariff Barriers

Currently, the Canadian government requires that imports of farmed salmon be certified free of certain diseases. Since few farms in competing countries go to the trouble of obtaining this certification, the regulation affords some protection against imports. As a result, domestic markets should be less competitive. Ontario, with its large population and bouyant economy, represents a logical target market, and it is a prime target for Eastern Canadian farmed production.

Summary

At present, the most logical target markets for B.C. farmed salmon are California, states in the mid Atlantic and New England areas, Central Canada and B.C. Target markets may have to be shifted as a result of changes in economic, demographic, and other factors.

The following sections recommend individual strategies for production, packaging, pricing, distribution and promotion which support the general positioning and target markets identified.

8.0 PRODUCT STRATEGY

8.1 Overview of Key Issues

The fact that salmon can be farmed allows considerable control over a wide range of product characteristics. Species, size, quality, time of harvest, flesh color, etc. can be controlled by the farmer to varying degrees, which distinguishes farmed from wild salmon.

In theory, the product can be "designed" to match the requirements of different market segments. In reality, the young B.C. industry yet can not exercise control over a number of key product characteristics. These were discussed in considerable detail in Section 6.0.

For example, early maturity problems with coho have meant a short-term loss of producer control over product weight and time of harvest.

Real problems of inventory valuation also exist. Both actual numbers and sizes of fish held in pens are proving difficult to estimate with current techniques. All the benefits of forward contracting are lost when the seller can not accurately determine what volumes he has available in specific size categories.

To some extent, these are problems associated with an immature industry. Successful techniques for delaying the onset of sexual maturity will emerge. Low-stress sorting and inventory valuation techniques will be developed, for example, to solve other problems. Nevertheless, they indicate the real challenge of trying to design and deliver a product strategy over the next few years. At this point, farmed salmon marketers face many of the same problems faced by their wild industry counterparts. They must plan on selling product for which volume, size, and timing of availability are not completely certain.

Within this context, Section 8.2 discusses those characteristics of the B.C. farmed salmon product that will be critical to its successful marketing. Recommended strategies in terms of species, size, product form, packaging and sale of lower grade product are outlined. These should be viewed as targets for producers, given existing conditions in the North American marketplace.

Before reviewing recommended strategies, it is important to note that we have not assessed the market's preferences for various product characteristics from the perspective of production costs. For example, the cost of producing larger size coho may be greater than the price premium paid for larger fish. More comprehensive cost of production analysis which incorporates both market prices and production costs is outside the scope of the study. Nevertheless, it is an important requirement for producers.

8.2 Recommended Strategies

Species:

Our market research indicates that indigeneous, Pacific varieties of salmon are generally preferred over Atlantics in the North American marketplace, if other attributes like quality and size are similar.

While chinook are preferred by expensive seafood restaurants and fish shops, there does not appear to be significant preference between chinook and coho in the other market segments. Therefore, we recommend that the decision on species to be reared primarily be based on ease and cost of production considerations, provided the majority of fish can economically achieve a 6-pound dressed weight.

Size Ranges:

The weight of whole, dressed salmon greatly determines its marketability to certain segments. For any product other than pan size, the critical minimum size level appears to be over 4 pounds. Fish less than 4 pounds compete with cheaper varieties of salmon and trout, cannot be economically cut or portioned, and as a result receive lower prices. The most versatile size category for whole, dressed salmon in the U.S. is the 6-to-9 pound category. Fish in this size category can be easily used in both restaurant and retail segments. To provide maximum marketing flexibility, we recommend B.C. producers target on the 4-to-6 and 6-to-9 pound (dressed) size range. However, the greater marketing flexibility (and higher producer returns) of larger fish have to be assessed in the light of bio-technical constraints, and costs of production. For example, it may be technically difficult or prohibitively expensive to produce coho in the 6-to-9 pound category.

It is unlikely that larger size classes can be achieved in the short run. It appears that B.C. producers will be faced with a predominance of smaller fish in the 2-to-4 pound and 4-to-6 pound range. Fish less than 4 pounds, in particular, could pose significant marketing problems in the short term. Product prices will be lower than forecast in business plans, and available markets will be more restricted (i.e., retail rather than restaurant). The nature and extent of problems associated with marketing small fish needs greater attention than was possible within the scope of this study.

Product Form:

B.C. farmed product will earn the highest producer returns sold in a fresh form. Freezing, smoking, and other more processed product forms do not represent large or viable market options over the long run.

There are definite trends away from whole, dressed product forms to pre-cut fillets or steaks in some market segments, particularly the grocery/supermarket segment and less expensive restaurants. We recommend that B.C. producers work with wholesalers/distributors on how best to meet this market requirement.

Quality Control and Grading Programs

The two most important attributes in the salmon product purchase decision are quality and fresh (as opposed to frozen) product form. A quality control and grading program is an important ingredient for achieving, maintaining, and communicating all-important quality attributes to the marketplace.

The presentation of a "quality" image is a cornerstone of our recommended product positioning and promotion strategy for the industry. Quality control and grading standards will be necessary if the B.C. industry wants to ensure a consistent, quality image.

We recommend that the farming industry continue to work with the processing industry, BCMAF, and DFO to design and institute such a program. However, attention must be placed on a number of program design and implementation issues. These are outlined in Section 12.0.

Packaging:

Packaging can serve two major functions. Well designed packaging can preserve the quality of product throughout the distribution chain. Secondly, it can serve a promotional function by presenting a consistent, identifiable symbol for B.C. production.

airline and truck transport. With airlines, for example, a box designed for packing fish with ice rather than gel-pack is required to maximize shelf life.

Packaging can also play a promotional role. However, its role in this area will not have a major impact because shipments are most often broken down and repacked at the wholesaler level. Also, because salmon is usually sold fresh on ice (or prepared as a restaurant entree), packaging is not normally used to identify the product for the final consumer. An exception to this is the use of gill tags by some firms, whose value as a promotional tool is unproven.

Sales of Lower Grade Product:

In Norway, three grades for farmed salmon have been developed: superior, ordinary and production. Superior grade fish are blemish free and are of excellent shape and skin colour. Fat content is limited to 15-20% and the flesh should be of even, acceptable colour. Ordinary grade fish have minor blemishes such as scale loss, small cuts and/or have less than ideal shape. Production grade fish are damaged to the point where they must be marketed filleted or otherwise processed. In 1985, about 89% of production was graded superior and about 8% was graded ordinary. The balance was production grade. Exports are restricted by the Norwegian government to superior and ordinary grade.

Although the precise grades are yet to be determined, we recommend that fish roughly equivalent to Norway's "production" grade not be exported, or if they are, not be identified as BCSFA product. This is an essential requirement for safeguarding a high quality image for B.C. production, and maintaining competitiveness with other supply regions. Product image tends to be governed by the lowest common denominator principle, i.e., the lowest quality level product will be more influential in establishing an overall

Proper design and packing are essential to maintain correct temperature levels while in transit. Temperature is the critical determinant in maintaining fresh quality and long shelf life. A superior grade salmon at the processing gate can quickly deteriorate into a second grade product with inadequate packaging. Many producers, processors, and airline carrier officials can provide graphic examples of the costly consequences of poor packaging.

Some industry observers feel the Norwegians may have gone overboard in this regard and have over-designed their packaging and specified an uneconomically high level of ice per standard carton. However, such stringent measures are justified if packaging is viewed as a form of insurance against quality deterioration. Moreover, additional ice gives an image of extra freshness. Norwegians have set the standards in packaging to which all other farmed product is measured. The Norwegians utilize a leakproof, styrofoam container that is 1 1/4 inch thick and has reinforced corners.

There are a host of examples in other agriculture sectors, from fresh asparagus to chicken, where packaging is afforded a similarly high priority in maintaining product quality.

The optimum design and type of packaging materials is a technical problem that goes beyond the scope of this marketing study.

The industry began to address this issue in the recent quality control workshop. However, there is a need to develop a set of packaging standards that forms part of an overall quality control program. Standard packaging should likely be adopted that would maximize shelf life, prevent breakage and leakage and facilitate transport in air and truck carriers. Different standards may also be required for

3. Smoked and other processed product (such as salmon pate) markets) will not be significant options for farmed salmon in the near to medium term. The North American smoked salmon market is limited in size, favours larger fish greater than 11 pounds, and will not pay premium prices over frozen wild products unless higher quality or cost savings can be clearly demonstrated. Success in the use of salmon in products such as pate will occur more from the marketing and enterpreneurial prowess of the producers than from any inherent advantages of the farmed product as a raw material source.

image in the marketplace than the highest quality product. Failure to keep low quality farmed salmon product out of the fresh market will negatively affect the image of the entire industry.

With respect to the actual disposal of lower grade product, a number of market opportunities are reviewed in Section 6.1. Our recommendations for the best market outlets for lower grade product are as follows:

1. Lower grade farmed fish harvested in the November-May period will still likely earn the best producer price in a fresh form. The reason for the downgrade will ultimately determine its marketability. An unbled fish or one with a damaged exterior or poor skin colour may still be acceptable as a filleted or steaked fresh product. Local domestic markets may be the best market for lower grade product, especially if the product must be moved quickly due to freshness or shelf life problems.
2. Freezing may be the best option if fish is harvested during market glut periods or during the wild season. However, the potentially higher quality of frozen farmed fish will not likely be recognized in the form of higher prices. For example, prices for frozen salmon production in 1985 from Norway averaged 10% less than fresh salmon. Prices for frozen salmon are mostly determined from supply and demand of wild stocks and therefore are not likely to yield high enough returns to be a viable product option over the long run.

9.0 PRICING STRATEGY

9.1 Overview of Key Issues

Recent market research indicates that demand for farmed salmon in most North American market segments may not be highly price sensitive. Price is not as important an attribute in the purchase decision as is consistent high quality or assured supply, for example. However, the seafood distribution system in North America has traditionally focused almost entirely on price, and quality differences among competing products are often not recognized.

Competitive pricing in this industry is, therefore, very important and cannot be ignored. However, B.C. producers will not likely win a battle for market share and sales volume built around price competition in the short run, given the experience and strength of the Norwegians and the emergence of new, low cost producers such as the Chileans.

Nor will the B.C. industry be a low cost producer, at least initially. Although it will enjoy significant transportation cost advantages over foreign competitors in servicing much of the U.S. market, much of this advantage could be lost due to higher farm production costs.

The B.C. industry is relatively capital intensive, and is still seeking to develop the most efficient production methods. In addition, the logistics and costs of moving large volumes of fish from farm gate to processing plant and on to an air (or road) distribution point remain uncertain. The end result is that B.C. producers will be producing relatively high cost fish initially.

A market penetration strategy based on below market pricing would not provide the best returns to the producer.

Furthermore, discounting or below-market pricing should not be necessary if B.C. producers can achieve product quality levels comparable to those of its major competitors.

Anderson's research indicates that B.C. farmed coho and chinook production would be prime contenders for market share in most market segments analyzed.

Competitors' pricing strategies are also important in determining B.C.'s approach. Norway in effect monopolized the winter fresh salmon market in the U.S. until 1985, when the first significant quantities of Chilean salmon began to appear. Landed prices to the U.S. remained remarkably stable from 1981 to 1985. The Norwegian industry, according to observers, has been reluctant to drop or discount prices in the face of competing supplies. This is consistent with a marketing strategy that emphasizes a high quality and value image. The strategy shifted somewhat in 1986, perhaps in response to emerging competition, with attractive financing terms and even consignment selling being offered by some Norwegian firms.

The first Chilean salmon entered the U.S. market at prices more than \$0.50/kg. (\$U.S.) below the prevailing Norwegian prices in the small size categories (1-3 kg.). At least at this stage the Chileans appear much more willing to price below market to gain a market share.

Along with these individual strategies, a general softening of farmed salmon prices occurred between 1985 and through most of 1986 in both European and North American markets. This seems to have resulted from both increased supplies and greater production efficiencies. Fresh salmon prices in some European markets in 1986 were reported to be 15% lower than 1985 prices. Comparable figures for the U.S. show also some declines across all size categories (see Section 6.0). It is generally expected that some additional price declines will

occur. The extent of the decline will depend on how well consumption growth keeps pace with increased supplies into the U.S. market, the supplies of other species of fresh fish and general economic conditions.

9.2 Recommended Strategies

1. The recommended image and product positioning for B.C. farmed salmon (discussed in Section 7.0) should allow for a focus away from price as the primary marketing tool. From a strategic point of view, we recommend that B.C. production be priced at or just below prevailing Norwegian prices, to support the superior quality image.

However, this positioning will only be justified if it is backed by consistent and equivalent quality compared to the product of its major competitor. Currently, wholesale prices for B.C. farmed product, at least on the U.S. west coast, appear to be more closely tied to the lower Chilean prices, than those for Norwegian product. The price difference between Norwegian and Canadian product is currently around \$1.00 per pound at the wholesale level. This may be due to prevailing market conditions and the predominance of smaller size classes in the majority of current B.C. production.

Nevertheless, as quality controls and larger, more consistent volumes of fish begin to emerge, we recommend B.C. producers begin pricing their product at the higher end of the market along with the Norwegians, wherever possible. In the long run, effective industry promotion programs should build an image and preference for B.C. which will justify premium prices.

2. Price should be used tactically, not strategically, as a marketing tool for selected promotions within target markets throughout the year. In other words, price discounts should be offered as an incentive for wholesalers and/or retailers to participate in promotions.

As well, B.C. producers/processors should be prepared to offer attractive selling terms, comparable to those of its competitors. Chilean and Norwegian exporters are reportedly offering easy credit terms, consignment selling, and guaranteed wholesale prices as part of distribution arrangements. Competition along these lines will no doubt intensify as supplies expand.

10.0 DISTRIBUTION STRATEGY

10.1 Overview of Key Issues

Distribution is defined here to include all the activities involved in physically moving farmed salmon product from the processing point to final consumer and includes transportation carriers and an array of middlemen.

A number of important issues associated with distribution have been discussed in other sections of the report, and need to be addressed in developing a distribution strategy. They are briefly summarized below.

The most critical issue with using the conventional seafood distribution system is potential loss of control over the product by the producer and/or processeor. Careless shipping can quickly turn a superior grade into a utility grade product. Wholesalers and distributors can repack, re-label, and alter the product form. All of these can lead to an inability to preserve the identity and quality of the B.C. farmed product.

It will be difficult initially to bypass or shorten the distribution chain. The farmed salmon industry will have to utilize the well-established, complex distribution network that now services fresh sales from the wild fishery. Shorter, more direct distribution channels are best for preserving the integrity and quality of the farmed product. However, industry production volumes will need to increase and become more stable before B.C. producers will be able to shorten the distribution network.

Significant economies of scale are achievable in the marketing, selling, and distribution function. Small, independent producers will have difficulty coordinating sufficient supply to achieve access on carriers, the most

economical shipping and brokerage fees, or the best prices in the marketplace.

10.2 Recommended Strategies

1. B.C. salmon farmers face a number of distribution alternatives. The major options include:

- . Individual farms independently marketing to large regional brokers/distributors (or more directly to local wholesalers or even retail restaurants in a given market area).
- . Individual farms marketing through the sales organization of either established processing companies or the larger, vertically integrated producers in the industry. This could entail either commission-based selling or direct purchases by these large firms.
- . Farms marketing in some form of collective basis. A number of cooperative selling arrangements are possible, including:
 - . joint ownership shared among a group of producers, processors, and a seafood sales organization;
 - . a traditional marketing cooperative organized to handle the marketing and sales of participating producers;
 - . a contractual arrangement between a group of producers and a common sales broker, established processing company, or one of the larger vertically integrated firms in the B.C. salmon farming industry.

We recommend that B.C. producers strive to establish selling arrangements on a collective basis, utilizing one of the options noted above, because there are significant economies of scale in selling and distributing that can be achieved by larger sales organizations. This would be particularly beneficial for smaller farms in the industry. Independent

marketing by smaller farms would be unlikely to produce the best net returns to the farmer. However, we do not recommend the legislated establishment of a marketing board or selling agency which entails compulsory participation of farms in the industry. Instead we recommend the establishment of cooperative selling arrangements which will work best when producers determine that it is in their best interest to work together.

2. Orderly production scheduling and planning will be critical in order to maximize sales volume, market share and producer prices. Supply continuity through the selling season will be an important industry capability and source of competitive advantage. The biotechnical and institutional requirements to achieve supply continuity need urgent attention by producers.

Achieving supply continuity is one of the major challenges facing the B.C. industry and orderly production scheduling will also require coordination among producers. Individual producers should therefore plan production in marketing groups or have production coordinated by a third party such as a processor or marketing group. The advantages of access to larger markets is another strong incentive to develop joint ventures, marketing consortiums, and other forms of horizontally integrated institutions. Joint ventures and marketing arrangements among producers, processors, and exporters are emerging in Norway and are being considered within the B.C. context. In the short term, the B.C. industry must strive to be capable of supplying weekly amounts continuously throughout the prime selling season between November and April. In the long run this should extend to year-round availability. This is particularly important if retail markets are to be pursued, which is likely given the initial predominance of production of coho in smaller size classes.

The Chilean and New Zealand pen-rearing and ranching industries have relatively short "windows" during which they can supply the North American market. Chilean production is mostly harvested in the February - April period while New Zealand salmon is harvested mostly in early winter. However, supplies are not consistent. Given the propensity of Chile to compete on the basis of price, B.C. producers would be advised to hold production off the market during these periods, until strong relationships with buyers can be established.

Ideally, the best way to preserve the identity and quality of farmed salmon is to exercise as much control over the distribution system as possible, and get to the end-consumer through the shortest, most direct selling chain.

However, the existing fresh seafood distribution system in North America is a well-established and relatively complex network of brokers, importers, and local wholesalers which will initially be difficult to bypass. In other words, in the short run, the existing network of middlemen will be essential in moving large volumes of production quickly to end users.

The best prospects over the longer term for shortening the distribution chain will exist with retail supermarket chains, or seafood restaurant chains like the Red Lobster group. These opportunities will emerge only when large, stable, and continuous production volumes (e.g., 30-50,000 pounds per week) can be achieved by a producer group or joint venture arrangement. The B.C. industry is at least 2-3 years away from meeting these requirements.

In the short term, we recommend that B.C. producers market production through established U.S. and Canadian distributors in target markets. In particular, producers should establish links with wholesalers who specialize in fresh seafood distribution. Smaller producers should individually or cooperatively market via established processors, larger integrated producers or common sales brokers who have already developed successful relationships with credible distributors and wholesalers. In the long term, we recommend that direct selling to retail chains be considered when consistent supplies over a period of several months can be guaranteed.

3. The B.C. industry will have to develop highly effective air and road transport capabilities to move fresh salmon quickly and efficiently to market. This will be especially critical with respect to air transport, where capacity constraints could emerge from Vancouver and potentially even Seattle distribution points due to shortages of wide body flights. It would be advantageous, particularly for smaller producers, to consolidate shipments in order to obtain lower freight costs and better access to, and service from, commercial carriers. We recommend that firms consider coordinating their transportation requirements with common carriers, especially airlines. Shipments should be delivered within 48 hours, following the Norwegian lead. Because there are few commercial flights to California from Vancouver and truck rates are less expensive, trucking to California is recommended. Shipments to the U.S. Eastern Seaboard should be flown from Seattle. Shipments to Ontario and Quebec should be flown on domestic air carriers.

11.0 PROMOTION STRATEGY

This section reviews conventional approaches to seafood promotion, and the recent efforts of the U.K. and Norwegian salmon farming industries.

The respective roles of industry-wide (generic) and individual firm promotion efforts are discussed, along with the differing requirements of individual market segments. The basis for an overall strategy is discussed in the concluding subsection. More specific details are provided in the discussion of BCSFA's marketing role in Section 12.0.

11.1 Conventional Approaches to Seafood Promotion

The commercial fishery in Canada and the U.S. has historically not promoted fresh and frozen whole fish product to any great extent in domestic North American markets. With salmon, most promotion efforts are restricted to private branding of canned products.

However, increased imports of fresh and frozen salmon in the U.S., particularly from Norway, have meant that the wild fishery can be expected to respond to this competition through increased promotion of wild products. Recently, the Alaskan Seafood Marketing Institute, which represents the majority of processors in Alaska, launched a \$1.2 million promotional campaign in the U.S. to increase consumption of frozen seafood.

In their campaign, promotion efforts are directed at seafood wholesalers in order to increase distribution of frozen products. A later phase of the campaign will be directed at consumers through network television advertising.

As previously indicated, promotion of Norwegian farmed salmon has not been very extensive in North America. The primary

promotional activity undertaken has been sales development work of importers and distributors through pricing sheets and sales literature. The Norwegian Fish Farmers Sales Organization (NFFSO) is also represented at major seafood trade shows in the U.S. In addition, large exporters in Norway have advertised Norwegian salmon in the trade press. The Norwegians can be expected to increase promotion efforts in the U.S. during the next few years. As an indication, a recent study analyzing the seafood distribution system in the U.S. was sponsored by the Norwegian government.

Norwegian promotional activities are undertaken primarily by the NFFSO. To date, their efforts have been largely directed at those within the trade, rather than end-consumers. However, as the importance of the retail segment grows and competition intensifies, use of multi-media and other standard consumer marketing techniques will increase.

The guiding principles behind the NFFSO's promotion program are to stress product quality and apply the quality image on a generic basis, regardless of individual farms involved. The perception of a single basic product is reinforced with a logo which is applied to a coordinated set of promotional materials. Promotional literature gives the perception of a clean healthy origin for the product coupled with a wide range of ways in which it can be prepared, presented and eaten. The sales organization has been able to bring virtually all of Norway's output within its promotional campaign. An important exception is MOWI, which markets salmon under its own brand and logo.

The NFFSO spent about \$2.0 million (\$Cdn.) on international sales promotion and the maintenance of international sales offices in Europe and the U.S. This represents about \$70 (Cdn.) per tonne of production.

In the U.K., most promotion is also conducted on a co-operative basis via the producers' association. A voluntary

local producer body, the Scottish Farmed Salmon Growers Association (SSGA), has been increasing its promotional activities through media advertising, development of recipes, and attendance at seafood trade shows. Most promotional efforts have been directed at increasing consumption within the U.K., with an educational message about how to buy, prepare and present salmon. The Association has also recently begun promoting in the U.S., primarily through trade show participation.

Marine Harvest Ltd., the largest Scottish producer, also conducts its own marketing and promotion campaign although it is a member of the SSGA. It has developed several branded, value-added products.

The SSGA has spent approximately \$40 per tonne of production on promotion in recent years. This represented close to \$300,000 (\$Cdn.) in 1985.

As the B.C. industry gets established, initial promotion efforts should be directed at the trade level, and supporting the sales efforts of wholesaler/distributors. Promotional tools, such as point of sale material, can be used by wholesalers to promote to retailers.

It is clear that as competitive supplies increase to the U.S. marketplace, and the demand in the retail segment grows, competition for market share will intensify in certain key market areas. Promotion of the superior grade B.C. product at the consumer level will play an increasingly important role in attaining and maintaining market share, as well as promoting overall growth in consumption.

11.2 Generic Versus Firm Specific Promotion

As the experience in both Norway and Scotland indicates, promotion efforts can be initiated by individual firms, or waged on an industry-wide basis by producer associations.

This latter approach is generally called "generic" promotion. Funds for generic promotion are typically raised by a levy on production or sales of each member. It focuses on building a market identity for the production of the entire industry or association regardless of the individual farms involved. Common quality standards and grading are essential requirements for such a scheme.

Promotion by large individual firms seeks to establish a brand identity for the farm's production. To date, only MOWI in Norway and Marine Harvest Limited in Scotland have established such marketing/promotional campaigns. Both are the largest, most prominent farms in their respective industries. Furthermore, Marine Harvest is heavily involved in processing and, similar to major fish processors in B.C., has developed value-added products more amenable to branding and differentiation.

Several B.C. farmed salmon producers appear to be pursuing a private branding route as well. They have developed company logos for use on gill tags, boxes, and promotional literature.

B.C. producers will have to decide the extent to which they will financially support generic promotion activities (through vehicles such as the BCSFA), and/or spend dollars on individual promotional efforts. (The two can be complementary -- one builds an image for B.C. salmon; the other hopefully builds a preference for one firm's production over another.)

For smaller farms, the benefits of co-operative promotion are obvious. Smaller farms do not have the financial resources to influence the distribution channel, much less have any impact on demand at the consumer level. Large producers, on the other hand, with limited advertising budgets and marketing personnel, may be able to increase sales through promotion.

But, several large B.C. producers competing independently in the North American marketplace against other national producer groups with substantial advertising budgets are likely to have less impact than would industry-wide promotion. This is particularly true when, in the longer term, expensive promotion will be required at the consumer level.

Well conceived and executed generic promotion can communicate a single, powerful message and identity to the marketplace (i.e., a choir as opposed to a loose collection of soloists).

Furthermore, it is not clear that private branding will be effective with a whole, unprocessed fresh product like farmed salmon. Private branding is more commonly associated with more value-added, processed product.

It will be difficult (and costly) to differentiate product from among farms within B.C., which is essential in establishing a private brand identity. On the other hand, B.C. production can more easily be differentiated from Norwegian or Scottish salmon because it originates from a different area (British Columbia) and features different species -- (Pacific as opposed to Atlantic).

Finally, industry-wide promotion of a "superior" grade product goes hand in hand with a quality control and grading program that seeks to set standards across the industry. The quality standards adopted by both the Norwegian and Scottish industries provide an important base for promotional programs. Promotion of the superior grade designation will be important in achieving the program objectives of higher sales and premium prices.

A properly designed generic promotion program can also accommodate and assist the marketing of individual firms. For example, generic brochures, posters, and point of sale material that provide space for the individual farm to be

identified can be developed. Recommended approaches are discussed in Section 12.0.

On the downside, generic promotion programs require a high degree of cooperation and commitment from individual producers. Benefits may be perceived to be disproportionately in favour of smaller farms, especially if funding is based on a pro-rated share of production, sales, (or in the case of the BCSFA, egg takes). Large producers may feel that their funds are better spent promoting their own private interests. Large producers have to be confident that their producer association is capable of designing and implementing an effective program. This task ultimately rests with the producer association staff.

11.3 Targeting on Specific Market Segments

The restaurant segment currently represents the largest market for fresh and frozen salmon in North America; the retail sector has the greatest growth potential. As a result, both segments should be the ultimate targets for promotion campaigns.

Fewer promotion tools are available for the restaurant segment than for the retail segment. Promotion aids for the restaurant segment include gourmet recipes, menu inserts, and table "tent" cards. Participation at HRI trade shows and trade journal advertising can also be directed at this segment.

Promotion tools for the retail segment include point of sale material, such as recipes and brochures, mass media advertising such as radio, television, newspapers, magazines and billboards, and trade shows and trade journal advertising.

In the short term, B.C. farmers will be producing salmon in sizes, which, in many cases, will be too small for the

restaurant segment. A significant proportion of fish will therefore be sold in the retail sector.

Promotional materials should therefore be directed more towards the needs of the grocery/supermarket and retail fish shop segments.

11.4 Recommended Strategies

1. Initial industry promotion efforts should be directed at the wholesaler/distributor level, rather than on generating end-consumer demand. As the industry expands and supplies to the U.S. increase, more focus will be needed on marketing techniques designed to increase the overall demand for fresh salmon at the consumer level, and raise the image and specific demand for B.C. superior grade. This will require more promotion at the end consumer and retail level.
2. Generic, industry-wide promotion can play an important role in the overall marketing of B.C. farmed salmon. This is proposed as an appropriate role for the BCSFA, and is discussed in detail in Section 12.0.
3. In the short term, promotion tools should be developed to meet the needs of the retail segment. It is expected that the majority of B.C. production over the next three to five years will be directed towards this segment. Specific examples of appropriate materials are described in Section 7.0.

12.0 ROLE OF THE BCSFA IN MARKETING

12.1 Introduction and General Principles

The BCSFA's primary role is to serve the collective interests of its producer members. The allocation of wild eggs among members has been a major function to date. With the industry's recent growth and development, a number of other needs have arisen which are best addressed by the collective action of an industry association. The recent Gillespie inquiry pointed out the need for the BCSFA to assume an active lobbying and communication function with government on behalf of salmon farmers. The Association's Board of Directors has also recognized the need to represent producers in any research and development carried out by public (and private) agencies in support of salmon aquaculture.

A third relevant area for BCSFA involvement is in marketing. A central purpose of this study has been to assess the requirements for a successful market access and penetration strategy for the industry, and then to define appropriate roles for the BCSFA in its implementation.

A number of general principles have guided our formulation of the BCSFA's role in marketing.

We believe that a fundamental objective for the BCSFA should be to establish a non-divisive role for itself in the marketing area. This will be a tremendous challenge. The industry contains a large number of small-scale producers, and a small number of larger, vertically integrated operations. Most industry analysts contend that increasing ownership concentration will emerge as the industry develops. The needs of these two types of producers may not always be compatible. The larger operations have their own marketing objectives and plans, and may have different marketing needs than smaller producers. The BCSFA must obtain

endorsement of a marketing strategy that will be perceived to be in the best interests of the majority of its members, both large and small. We believe strong arguments can be made in favor of a number of industry-wide, marketing related initiatives that should receive the support of most producers. We have not, however, had the opportunity to present these concepts to a broad cross-section of the industry. The BCSFA will need to maintain flexibility and be willing to adapt its marketing role to the feedback it receives on the recommendations in this report.

According to the first principle, the BCSFA should not be directly involved in selling salmon on behalf of its members. Rather, the BCSFA's most appropriate role in marketing should be that of providing marketing support to its members.

Another fundamental principle that the BCSFA should adopt is to focus on the requirements for longer term success of the B.C. industry. At the current low levels of industry production, and excess demand for fresh salmon, little need exists for a major market support function. Most producers should have few problems making sales this year and next year.

However, the major assumption underlying our recommendations in areas such as promotion is that the market situation will be quite different within two years. Rapidly increasing supplies of farmed salmon to the U.S. market may result in lower average prices and create a more competitive market situation. This situation will require both strong image building for B.C. farmed salmon vis-a-vis its competitors, and missionary promotion efforts designed to generate more demand.

Given these general principles, the next section outlines a role for the BCSFA in a number of marketing support areas.

12.2 Recommended Marketing Role

The BCSFA could assume a variety of roles in the marketing area. Each one has different implications for the extent of involvement and intervention in the marketing function. We have selected a range of activities designed to best serve the collective interests of the industry, while producing complementary support to the marketing and selling activities of individual producers.

The Association should establish the following marketing support objectives:

- . to design and implement market intelligence programs for gathering sales statistics, monitoring competitive strategies, and reviewing new trends or significant changes in the marketplace;
- . to design, implement, and govern a quality control and grading program on behalf of members to ensure consistent high quality standards both in the fish themselves and through packaging and distribution of those fish;
- . to provide generic promotion support for the marketing efforts of members and processors in target markets and against the primary product positioning. This "missionary" marketing support should be aimed both at market share penetration and the creation of new demand for fresh salmon generally, and BCSFA member-produced fresh salmon specifically;
- . to work with members and processors to develop new markets and new wholesale and retail customer groups within these new markets.

These objectives translate into four main activity areas:

- . market intelligence activities;
- . quality control and grading programs;
- . generic promotion activities;
- . general research activities.

Market Intelligence Activities

A key role for the Association will be the ongoing pursuit of new markets and analyses of sales data and market intelligence on which to base refinements to the plans and new activities. The marketplace will be very dynamic, and the ability to adapt to change will be a significant ingredient for success. It is important that the Association recognize the need for constant expansion of markets throughout urban areas in North America and abroad, and commit to excellent information from the field.

The BCSFA should provide accurate market and economic information to both buyers and producers on such items as harvest levels, inventories, prices (farm gate and wholesale) and market outlooks. Such information would give producers and buyers a sounder basis on which to make decisions and take action. An especially critical area at present is the lack of reliable forecasts of production and harvest levels for the B.C. industry (by year and month). Present forecasts are inadequate for the development of rational marketing plans. More sophisticated forecasting methods for B.C. farmed production need to be developed and applied.

This is an essential ingredient in trying to match demand and supply conditions in the U.S. market, and in anticipating gluts and other market disruptions that can cause short-term price reductions for B.C. producers. The BCSFA must also continue to monitor and update production forecasts from other supplying regions as part of this requirement.

A relevant area is the farm gate (or FOB processing plant) prices. The periodic collection and dissemination of average price and quantity data which could be done on a confidential basis would be a valuable source of information for producers.

Similarly, data on wholesale prices for farmed salmon in various U.S. markets is available on a weekly basis. Private firms such as Urner-Barry produce price and quantity reports for a major U.S. regional markets on a weekly basis, available for an annual subscription fee. These data could be analysed to provide information on seasonal price and import trends to help B.C. producers plan the best times (and areas) in which to sell.

The BCSFA should establish a process by which such production and market information is collected, analyzed, and disseminated to members. This activity does not necessarily have to be the responsibility of the BCSFA. It could be developed by the B.C. Ministry of Agriculture and Fisheries. (Some of the information in areas such as inventory and production levels will have to be collected on a confidential basis and therefore will require the consent of the majority of BCSFA members.)

In addition to market information, the BCSFA could initiate market research that would be of collective benefit to the membership. Continuing analysis is required of issues such as:

- . potential imposition of tariffs and countervailing duties in fresh fish imports into major markets like the U.S.
- . changing trends in the U.S. marketplace,
- . opportunities for small-sized fish (two to four pounds),
- . strategies of competitors,
- . the specific product preferences of certain target markets,

- . market potential of new product forms for farmed salmon (e.g., smoked salmon, high-quality frozen, pates, and high value processed products); and
- . export potential in new markets, such as Japan.

Significant funding contributions for such research should be available from various government departments and programs. Another possible market information service would be to establish a formal system for distributing marketing-related inquiries to interested BCSFA members.

Quality Control and Grading Program

The BCFSFA has already begun defining a role for itself in this area. We endorse the concept of a quality control and grading program designed by the industry association, but a number of program design and implementation issues need more careful analysis by both the association, governments and industry participants. Specific comments on the technical adequacy of many of the proposals in the draft guidelines go beyond the scope of this study. Our comments are restricted to the marketing implications of the quality control and grading program as currently proposed.

The presentation of a "quality" image is the cornerstone of our recommended product positioning and promotion strategies for the industry. Therefore, quality control and grading standards will be necessary if the B.C. industry wants to portray a consistent, quality image to the marketplace.

We endorse the usage of a superior grade designation and the accompanying BCSFA logo as a marketing symbol and a quality assurance seal. The quality control guidelines and grading standards that accompany a "superior" designation have to be strictly enforced and adhered to. Nothing is more damaging to a marketing image than a poor quality product marketed as

a superior grade. Marketing objectives are better served by a minimum program of standards that are strictly enforced, than by a stricter program minimally enforced.

The producers should establish the grades, with input from processors and the trade. One of the problems with the set of quality control and grading standards that emerged from the workshop is that they need to be evaluated from both a buyer/trader and producer perspective. Grade levels are useless if they don't reflect real differences in value (and price) to the trade and consumers. Similarly, it is equally impractical to set criteria so demanding that only a small percentage of B.C.'s production qualifies for a "superior" designation.

We endorse the BCSFA's current plans to obtain feedback from the industry on the recent workshop results. We would recommend that BCSFA initially present the grading criteria and quality control proposals as a code or set of guidelines for the industry to practice.

The development of a set of enforceable regulations and "superior" designation for promotion purposes requires more careful analysis and testing over the next six months. For example, an independent study could be carried out during the remainder of the selling season to determine reaction from producers, processors and the seafood trade to the proposed standards. Also, the percentage of production likely to fall into the proposed grade classifications should be determined.

In addition to these program design issues, there are some equally important implementation and enforcement issues. The enforceability of association regulations, particularly among non-member processing firms, may be impractical.

The BCSFA and the federal and provincial governments should jointly determine how enforcement will be carried out. Health and Welfare, DFO, BCMAF and other government departments all have regulatory roles in certain areas. For example, the extent to which DFO can and should be involved in inspecting export sales for more than "wholesomeness and integrity" needs to be assessed. Producer and processor compliance costs need to be estimated, and the logistics (and costs) of enforcement need to be detailed. It may be more efficient and effective for government inspectors to carry out the quality control inspections, rather than have separate, BCSFA inspectors. In addition, the extent to which the proposed quality control and grading standards for the farmed industry will be integrated with requirements in the wild fishery has to be determined.

Generic Advertising and Promotion Activities

As the U.S. marketplace becomes increasingly competitive, there will be a requirement to stimulate new demand and build a strong image and preference for B.C. fresh salmon.

First and foremost, it is important for the industry in British Columbia to commit to an aggressive marketing program before major supplies become available in key target markets. A strong initial campaign is encouraged to ensure good market share penetration against the major competitors.

The appropriate role in this area is for the Association to support the marketing efforts of its members. The recommended ingredients of such a strategy are:

- (a) to design and develop a range of printed collateral promotional materials for use by members in developing promotions with wholesalers and retailers;

- (b) to oversee an ongoing generic or missionary public relations and communications campaign directed at promoting the use of salmon generally, and British Columbia, BCSFA-produced salmon specifically;
- (c) to represent the members at trade shows and consumer food shows on an international level.

Each of these areas is discussed below, but it should be recognized that the industry will need to maintain maximum flexibility over the first year or two of major marketing activities. As supply reaches demand, competitors will be developing new strategies and the marketplace will undergo substantial change. The ability to adapt to these changes will be critical.

(a) Promotional Materials

The best way for the Association to provide marketing assistance to members and to support public relations efforts is to design and develop a wide range of promotional materials for use in these programs. By doing this, the Association maintains a consistent, high quality graphic image in the marketplace in all marketing applications. The basic graphic elements recommended for all these materials are the following:

- The BCSFA logo with the blue on silver colour scheme;
- The designation Fresh Pacific Salmon from British Columbia, Canada or British Columbia Fresh Pacific Salmon, Canada, or perhaps B.C. Fresh Pacific Salmon, British Columbia, Canada;
- the selected support slogans;
- the grading standard;
- the producer or processor's name.

The reason for recommending the existing BCSFA logo design is that it is very effective and implies quality. It could also come to be seen as a consistent symbol for the product and the product quality when featured in all promotional materials and on packaging.

The BCSFA should design and fund the initial development costs for a coordinated set of promotional materials. Individual producers could then pay for the actual production costs for a run of posters, for example, for use in their individual marketing and selling efforts.

The proposed range of promotional materials and estimated development costs for design and production are as follows:

Video/slide show - \$40,000 - \$50,000

- . for trade and consumer shows, training programs, television exposure.

Posters - \$6,000 - \$8,000 for about 10,000 copies

- . available to distributors for retail promotions, distribution to key media and hand-outs at trade shows.

Brochures - \$20,000 each version in quantities of 100,000

- . in two versions, one for trade shows and industry - related publicity that focuses more on technology of fish farming, nature of the industry, range of species, quality control and another for consumer exposure at retail promotions, possible direct mail campaigns with a focus on the benefits of salmon and the choice of B.C. produced salmon.

Standard format advertising layouts - \$5,000

- for newspaper - black and white and one colour
- for magazine - 4 colour
- for insertion in chain flyers
- a standard layout allowing for specific copy to be dropped in for different messages in different markets.

Trade show portable display booth - \$20,000

- for trade shows, demonstrations in retail outlets, consumer shows (existing may suffice)

Mobile display units and pricing cards - \$5,000

- designed for use in retail chain and fish specialty stores during key promotional periods.

Recipe booklets - \$25,000 for quantities of 100,000

- these are an important element for chain store and specialty store promotions, for distribution through the media, and for handout at trade shows. An important area in the future will be microwave recipe development.

Training manuals - \$5,000

- to provide fish handling information to retail staff as part of cooperative promotions and for use with the media.

Standard press release format, letterhead and/or tabloid

- \$2,000, for press mailout and updating the distribution

(b) Public Relations and Communications Program

The second most important support area for the association is to provide a strong and consistent communications effort through trade shows, the media, the distribution network and, in some test market cases, to end consumers through direct mail. It is recommended that the Association retain, part time, one locally well known food expert in each of two key markets (e.g., California and Ontario) to represent the Association in regular visits to appropriate media (food editors, lifestyle editors, etc.), senior retail sales personnel, and radio and television programs. The objective would be to push a strong generic "missionary" effort on behalf of salmon generally and B.C. Fresh Salmon specifically, using all available promotional tools as backup. It is suggested that appropriate part-time candidates could be located in both markets for perhaps \$25,000 per year with matching promotional budgets for expenses and travel. A third person working with the Association in developing new markets could take on a similar role within other target markets.

The Association should undertake to produce and distribute regular update reports in the form of releases or an industry tabloid to keep the media, distribution system, retailers, and consumers informed of events in the industry. A tabloid issued three to four times per year would cost approximately \$10,000 including mailout. In a "release" format the costs could be about half.

It is recommended that the Association, through local distributors, sponsor training seminars for wholesalers/distributors and retail staff on identifying, handling and preparing high quality fresh salmon. This could also be an important promotional vehicle in key target markets. In particular, this could provide good inroads into the larger chains and specialty stores. Seminars could also be designed for restaurant chefs. With the right training manuals prepared in advance, costs could be kept down to

It is also recommended that the Association sponsor at least one annual familiarization trip to British Columbia for important retail customers, distributors, and media, selected on the basis of their proven support for the marketing efforts of members. This could be an extremely effective sales and promotion technique. Each group trip could include visits to farms and the processing plants and a day on the water sports fishing for B.C. salmon. Costs are estimated in the range of \$10,000 to \$20,000 per year.

(c) Representation at Trade Shows

The Association should represent all members at selected trade shows and some consumer shows. The appropriate shows are already known to Association staff. A proper portable display booth system can cost up to \$20,000 to produce. The video/slide show and promotional materials noted above are the support tools for these shows.

The promotional strategies recommended above are aimed primarily at the retail sector where greatest demand growth is expected. No specific promotional recommendations have been made for the restaurant trade, where the strongest marketing tool will be a consistent, high quality supply.

One way to enhance quality image, is to provide restaurant customers with high quality table cards or descriptive menu inserts that talk about the fresh salmon offered on the menu and why it is the best.

The challenge for BCSFA will be to enlist the support of all Association members and other industry participants (such as traditional processing companies) for this promotional program. Some larger producers may feel that they want to spend their promotional dollars on their own product (and brand), rather than on participating in industry-wide initiatives. The BCSFA may have to modify the recommended

promotional program in order to gain the support of the majority of the membership, including both large and small producers. For example, producers may prefer that the focus of BSCFA's promotional campaign be on the "missionary function" (e.g., creating general consumer awareness in the handling and preparation of seafood through recipes, point of sale literature) rather than on creating a B.C. industry-wide image.

General Research Role

General research needs in the industry include marketing, distribution and production elements. The BCSFA could play a useful catalyst role in seeing that such research is undertaken. In many cases, a large part of the funding for these studies should be available upon request from various government programs. Examples of research requirements include:

- . development of formal production forecasting methodologies for the industry;
- . cost of production surveys and comparative analysis with other supply regions;
- . an analysis of the benefits, costs and success requirements of cooperative selling arrangements (e.g., joint ventures, group contracts with common sales organizations);
- . an assessment of the benefits and logistics of shared transportation networks;
- . research into packaging design;
- . an assessment of requirements for selling farmed salmon to large-scale retail or restaurant chains.

12.3 Planning Timetable

The initiation of a market intelligence and generic promotion program described above cannot be accomplished at once, and priorities from both a timing and budget point of view must be established. Assuming that major supplies will be ready

for market in the fall of 1988, the following is a proposed timetable:

First Half of 1987

- finalize mission, structure, and develop final overall marketing plans;
- design and develop all collateral materials and audio-visual (early estimate of total costs - \$100,000 to \$150,000);
- finalize quality and packaging standards and graphics;
- develop data and review distribution for key target markets;
- develop media lists, key public relations contacts and review possible spokesperson;
- finalize plans for research, market analysis and sales reporting;
- implement market intelligence program in all markets.

Second Half of 1987

- begin promotional and public relations programs in local markets (co-op funding);
- finalize marketing programs for key target markets;
- finalize public relations plans including selection of support roles.

First Half of 1988

- implement public relations programs in key target markets and all secondary markets for ongoing activity;
- prepare a launch of marketing programs in advance of supply availability.

Second Half of 1988

- product and promotional launches in key target markets;
- finalize marketing plans for secondary markets for launch in first half of 1989;

- continue public relations efforts in all markets;
- review overall marketing efforts to date to revise 1989 onwards.

12.4 Funding Implications

We have not conducted an extensive analysis of funding sources for the recommended marketing activities of the BCSFA. Our preliminary estimates of the costs of the proposed promotional program are in the order of \$150,000 - 200,000 per year over the next two years. Estimates for the costs of implementing and enforcing quality control and grading standards cannot be developed until the program is more firmly established. Much of the market and general research may qualify for substantial funding assistance from government sources which could reduce costs to the BCSFA.

APPENDIX A

Existing and Potential Salmon Demand by State

EXISTING AND POTENTIAL DEMAND BY STATE (TONNES/YR)

Region/State	Rest Demand Current	Rest Demand Potential	Groc/Super Demand Current	Groc/Super Demand Potential	Fish Mkt. Demand Current	Fish Mkt. Demand Potential	Total Demand Current	Total Demand Potential
NEW ENGLAND								
CONN	1,215	1,727	323	674	534	764	2,572	3,166
MAINE	442	629	164	340	345	493	951	1,465
MASS	1,957	2,782	318	663	1,142	1,635	3,417	5,080
NEW HAMPSHIRE	408	560	117	244	180	258	705	1,052
RI	365	519	41	85	264	378	670	982
VERMONT	253	359	81	168	71	102	405	630
SUB TOTAL	4,640	6,596	1,043	2,177	2,536	3,631	6,121	12,404
MID ATLANTIC								
DELAWARE	105	149	46	95	111	159	262	404
DIST COL	152	216	47	89	50	71	245	377
MARYLAND	560	796	246	513	1,055	1,511	1,861	2,819
NEW JERSEY	1,000	1,348	268	559	922	1,335	2,500	3,741
NEW YORK	3,591	5,103	1,095	2,296	1,608	2,345	6,025	9,735
PENNA	1,981	2,816	304	1,678	656	939	3,441	5,433
VIRGINIA	1,015	1,442	585	1,222	495	709	3,095	3,373
WEST VIRG	296	420	209	476	21	30	526	886
SUB TOTAL	9,001	12,791	3,295	6,878	4,959	7,099	17,255	26,759
MID CENTRAL								
ILL	1,593	2,264	385	803	267	383	2,545	3,450
INDIANA	736	1,045	181	379	64	92	921	1,516
KANSAS	1,099	1,560	357	746	189	270	1,644	2,576
MICH	1,321	1,877	354	739	143	205	1,819	2,622
MISS	784	1,114	181	378	85	121	1,050	1,613
SUB TOTAL	5,532	7,861	1,458	3,044	748	1,071	7,736	11,676
N W CENTRAL								
IDAHO	239	340	94	197	26	37	359	573
KANSAS	205	291	84	175	23	33	311	459
MINN	319	454	122	254	20	28	461	716
MONTANA	88	126	34	72	11	15	133	211
NEB	133	189	49	103	8	11	190	302
ND DAKOTA	56	80	26	55	3	4	85	135
S DAKOTA	62	99	26	55	2	3	89	146
SUB TOTAL	1,102	1,566	436	911	92	131	1,630	2,606
SO ATLANTIC								
ALABAMA	616	875	462	965	213	306	1,292	2,146
FLORIDA	2,395	3,404	722	1,526	1,356	1,942	4,484	6,874
GEORGIA	1,111	1,579	635	1,326	484	693	2,231	3,598
NC CAROL	1,185	1,663	733	1,530	625	895	2,543	4,114
S CAROL	654	929	380	793	373	534	1,406	2,256
SUB TOTAL	5,961	8,471	2,943	6,143	3,052	4,369	11,955	18,962

EXISTING AND POTENTIAL DEMAND BY STATE (TONNES/YR) (cont.)

Region/State	Rest Demand Current	Rest Demand Potential	Groc/Super Demand Current	Groc/Super Demand Potential	Fish Mkt. Demand Current	Fish Mkt. Demand Potential	Total Demand Current	Total Demand Potential
S E CENTRAL								
ARKANSAS	308	438	145	302	83	119	536	859
KENTUCKY	382	543	189	395	56	80	627	1,017
LA	523	744	245	511	583	834	1,350	2,088
MISS	277	393	174	363	151	216	602	972
MISSOURI	621	982	170	355	42	60	833	1,297
TENN	545	774	252	527	48	68	845	1,369
SUB TOTAL	2,656	3,775	1,175	2,452	961	1,376	4,792	7,603
S W CENTRAL								
NEW MEX	211	300	63	132	18	25	292	458
OKLA	479	681	261	546	29	42	770	1,269
TEXAS	2,052	2,916	1,086	2,268	475	680	3,614	5,864
SUB TOTAL	2,743	3,898	1,411	2,946	522	748	4,676	7,591
MOUNTAIN								
ARIZONA	184	262	104	217	38	55	327	534
COLO	225	319	93	194	52	75	370	588
IDHO	64	90	44	91	3	5	111	187
NEVADA	60	85	15	31	14	20	88	136
UTAH	82	117	52	108	13	19	147	244
WYOMING	37	52	18	38	3	4	58	94
SUB TOTAL	651	926	325	679	124	177	1,160	1,782
PACIFIC								
ALASKA	183	260	48	101	56	80	287	440
CALIF	8,154	11,587	1,159	2,419	1,533	2,195	10,846	16,201
HAWAII	337	479	69	145	232	332	638	956
OREGON	928	1,319	317	662	205	293	1,450	2,274
WASH	1,345	1,911	419	875	408	584	2,172	3,370
SUB TOTAL	10,947	15,556	2,013	4,202	2,433	3,483	15,393	23,241
TOTAL US	43,236	61,440	14,099	29,430	15,427	22,085	72,761	112,956
CANADA	8,877	12,615	2,910	6,075	1,864	2,782	13,452	21,672
TOTAL TH AMERICA	52,113	74,055	17,009	35,505	17,091	24,468	86,213	134,629

US RESTAURANTS, GROCERY STORES, FISH MARKETS; 1986.

STATE	AREA	ALL REST	ALL GROCER	% GROC	FISH MKTS	% FISH MKTS
CONN	1	4374	1485	34.0%	171	3.9%
MAINE	1	1592	756	47.5%	111	7.0%
MASS	1	7045	1460	20.7%	368	5.2%
NEW HAMP	1	1470	537	36.5%	58	3.9%
RI	1	1315	187	14.2%	32	2.5%
VERMONT	1	910	371	40.8%	22	2.5%
DELAWARE	2	664	340	51.2%	58	8.7%
DIST COL	2	961	317	33.0%	26	2.7%
MARYLAND	2	3536	1827	51.7%	170	10.6%
NEW JERSEY	2	8211	1991	24.2%	486	5.9%
NEW YORK	2	22674	8148	35.9%	854	3.8%
PENNA	2	12511	5981	47.8%	342	2.7%
VIRGINIA	2	6409	4355	68.0%	258	4.0%
WEST VIRG	2	1867	1554	83.2%	11	0.6%
ILL	3	13987	5321	38.0%	359	2.9%
INDIANA	3	6457	2509	38.9%	67	1.0%
MICH	3	9636	4940	51.3%	183	1.9%
OHIO	3	11597	4896	42.2%	139	1.2%
WISC	3	6884	2502	36.3%	82	1.2%
IOWA	4	3914	1898	48.5%	36	0.9%
KANSAS	4	3346	1691	50.5%	32	1.0%
MINN	4	5221	2452	47.0%	28	0.5%
MONTANA	4	1445	690	47.8%	15	1.0%
NEB	4	2171	989	45.6%	11	0.5%
NO DAKOTA	4	924	526	56.9%	4	0.4%
S DAKOTA	4	1012	532	52.6%	3	0.3%
ALABAMA	5	3958	4267	107.8%	138	3.5%
FLORIDA	5	15395	6756	43.9%	877	5.7%
GEORGIA	5	7142	5862	82.1%	313	4.4%
NO CAROL	5	7613	6765	88.9%	404	5.3%
S CAROL	5	4202	3505	83.4%	241	5.7%
ARKANSAS	6	3172	2817	88.8%	113	3.6%
KENTUCKY	6	3929	3682	93.7%	76	1.9%
LA	6	5381	4764	88.5%	755	14.8%
MISS	6	2847	3383	118.8%	206	7.3%
MISSOURI	6	6383	3316	52.0%	57	0.9%
TENN	6	5603	4915	87.7%	65	1.2%
NEW MEX	7	2235	864	38.7%	17	0.8%
OKLA	7	5075	3565	70.2%	25	0.5%
TEXAS	7	21723	14811	68.2%	959	4.4%
ARIZONA	8	4147	1703	41.1%	44	1.1%
COLO	8	5052	1521	30.1%	60	1.2%
IDAHO	8	1431	716	50.0%	9	0.6%
NEVADA	8	1344	241	17.9%	16	1.2%
UTAH	8	1854	846	45.6%	15	0.8%
WYOMING	8	825	298	36.1%	3	0.4%
ALASKA	9	865	309	35.7%	20	2.3%
CALIF	9	38614	7424	19.2%	680	1.8%
HAWAII	9	1596	445	27.9%	104	6.5%
ALASKA	9	4395	2030	46.2%	52	1.2%
WASH	9	6669	2686	40.2%	103	1.5%

A-4

L	301283	145746	48.4%	9274	3.1%
CANADA	46584	21240	45.2%	351	1.0%
NEW ENGLAND	16706	4796	28.7%	617	4.5%
MID ATLANTIC	56833	24513	43.1%	2583	4.5%
N E CENTRAL	48561	20168	41.5%	725	1.5%
N W CENTRAL	18033	8778	48.7%	129	0.7%
SO ATLANTIC	38310	27155	70.9%	1973	5.2%
S E CENTRAL	27315	22877	83.8%	1312	4.8%
S W CENTRAL	29033	19240	66.3%	499	1.7%
MOUNTIAN	14653	5325	36.3%	142	1.0%
PACIFIC	51839	12894	24.9%	1092	2.1%

APPENDIX B

Description of the Seafood Distribution System

Role of Wholesaler

Wholesalers usually take title and physical possession of goods. Wholesalers usually have distribution centres where additional processing such as steaking and filleting and substantial repacking are often undertaken. Wholesalers usually also have warehousing facilities and delivery trucks which service local customers. In the case of the fresh and frozen fish, trucks are refrigerated.

Depending on quantities and the extent of additional services provided, markups at the wholesale level are usually between 15% and 30%.

Some large wholesalers in major seafood trading centres such as Vancouver, Seattle, San Francisco, Los Angeles, Chicago, Boston, and New York can also be described as regional wholesalers. Regional wholesalers, in turn, sell to wholesalers in local centres who distribute directly to restaurants and retail stores. Examples of the geographic areas that specific regional wholesalers serve are shown below.

Wholesaler	Geographic Areas Served
Albion Fisheries, Vancouver	B.C. and Alberta
Galetti Brothers, Los Angeles	Southwestern U.S.
Chicago Fish Trading House, Chicago	Midwestern U.S.

Role of Brokers

In contrast to wholesalers, fish brokers usually do not take title or physical possession of goods. However, fish brokers usually do about everything that an employed sales force can do. In exchange for a commission of between 5% and 10% of sales, fish brokers call on wholesalers, make sales,

coordinate shipments, handle complaints, and provide information to both the supplier and the wholesaler. Brokers usually conduct credit checks and handle collections of accounts.

Brokers usually serve wide geographic areas. For example, Dory Seafoods in Seattle markets farmed salmon to wholesalers located throughout the U.S. Some brokers who specialize in farmed salmon may also be classed as importers. For example, T.M. Tobin & Co. in San Francisco is a broker who is the largest importer of Norwegian farmed salmon in northern California.

Independent transport companies are usually responsible for transporting the product from producers or processors to buyers and serve large regional or national markets. A typical example would be Brown Line, a transport company based in Mount Vernon, Washington, which specializes in hauling fresh fish and fresh produce and has regular routes from Vancouver to California.

Typical Pricing and Margin Levels

Knowledge of the pricing and margin levels of various points in the distribution system is important for establishing competitive prices and interpreting price data.

The typical pricing structure that might face a B.C. producer is provided in the exhibit below. It is based on discussions with industry officials at each level of the distribution chain. It assumes a distribution channel involving the use of a centralized processing facility, a broker or large regional wholesaler, and a smaller local wholesaler/distributor who sells directly to restaurants or retail stores.

TYPICAL PRICING STRUCTURE FOR B.C. FARMED SALMON (6-9 LB RANGE, HD ON, DRESSED)

	CDN \$/lb	US \$/lb ¹
Farm Gate Price	3.30	
Recovery (round to dressed head on)	85%	
Net Fish Cost to Processor	3.89	
Transport Cost to Processor	.10	
Processing Costs (labour & materials)	.30	
Price -- FOB Processing Plant	4.29	
Transport to Market ²	.25	
Landed Price to Broker/Importer	4.54	3.27
Brokerage Fee (7%)	.32	.23
Selling Price to Local Wholesaler/ Distributor	4.86	3.50
Wholesaler Markup (15%)	.73	.53
Selling Price to Restaurants and/or Retailers	5.59	4.03

¹ Assumes an exchange of \$US1 = \$CDN.72

² This is equal to airfreight to Los Angeles

Prices and costs for certain key pricing levels are shown in both U.S. and Canadian dollars.

The key competitive price for the B.C. producer will be the landed price to the first point of distribution in various markets which will be the selling price to the broker/importer or regional wholesaler. This is the price that will be compared to the landed price of deliveries from other supply areas. The hypothetical example in the exhibit, beginning with a \$3.30 farm gate price, yields a landed price

in the U.S. market (assuming average freight costs of \$.25) of about \$US 3.50. This \$US 3.50/lb figure is in the range of prices for B.C. farmed salmon as quoted in the Urner-Barry Seafood Price Lists in February, 1987.

Costs to the consumer at the retail and restaurant level using standard markups are shown in the following exhibit. The purchase price is taken from the previous example.

	Retailer (whole)	Restaurant (fillet)
Cost	\$5.59	\$ 5.59
Yield	100%	87%
Net Cost	5.59	6.43
Net Cost/Unit	5.59	3.22 (8-ounce fillet)
Markup	1.96 (35%)	9.73 (300%)
Sub-total	7.55	12.95
Garnishings	N/A	1.00
Selling Price	\$7.55	\$13.95

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BIOPHYSICAL CRITERIA
FOR SITING SALMON FARMS
IN BRITISH COLUMBIA

1st **DRAFT**

BIOPHYSICAL CRITERIA FOR SITING SALMON FARMS
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by

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AQUACULTURE AND COMMERICAL
FISHERIES BRANCH
MINISTRY OF AGRICULTURE AND FISHERIES

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INTRODUCTION

The suitability of a marine site for fish farming is largely determined by the biological and physical requirements of the culture species, and the ability of the site to meet those needs within the constraints of a net pen rearing operation. The site must also be amenable to the installation and maintenance of a fish farm facility. This report describes the biophysical factors that are important in the evaluation of a site's potential for fish farming. These factors can be grouped into the following categories.

<u>Water Quality Factors</u>	<u>Physical Factors</u>	<u>Biological Factors</u>
Temperature	Currents	Plankton
Dissolved Oxygen	Depth	Marine Plants &
Salinity	Wind & Wave Action	Fouling Organisms
Pollution	Geomorphology &	Predators
Hydrology	Substrate	

All biophysical factors are important, and no single factor is completely independent of another. In many instances, it is an interaction of physical and biological conditions that will ultimately determine site suitability. Nevertheless, some factors are more important than others. These are usually determined by the biological requirements and tolerance ranges of the culture species, and include temperature, dissolved oxygen, salinity, and an absence of harmful organisms (mainly phytoplankton). Secondly, factors that influence the long term viability of a site must be considered. These include currents, water depth, pollution, hydrology, and geomorphology. These factors influence long term survival of farm stock, as well as the impact that the operation will have on the site. Finally, factors that affect the feasibility of an operation should be assessed. Farm systems must withstand wind and wave action, deal with marine plants and net fouling organisms, and protect stock from predators. An overriding consideration is the ability to mitigate adverse conditions; some substandard factors can be alleviated by technological applications or improved husbandry practices, others cannot.

Optimal ranges for some biophysical factors are determined by tolerance of the culture species, while others are defined by the facility's ability to withstand adverse weather and sea conditions. Ratings for biophysical factors that influence fish health and growth were determined from the requirements of Chinook salmon, which is considered to have the lowest tolerance range. It should be realized, however, that other species have higher tolerances and may be able to withstand conditions

that are substandard for Chinook salmon. Ratings for the biophysical factors that are important to fish farm facilities were determined from the design specifications of systems presently employed in B.C.

It is necessary to recognize the relationship between each biophysical factor when determining a site's suitability. For example, a site may have a poor ranking for wave exposure, but may have temperature and dissolved oxygen levels that are optimal for salmon farming. The latter factors are important to fish health and growth, while the former is important to operational cost and feasibility. In the final analysis, therefore, site suitability is determined by a balance between the ability of a site to support the culture species, and conditions that favour maintenance of a farm operation.

This report is divided into sections for each biophysical factor. Beginning with the rating scale and its rationale, each section provides a discussion of how a factor relates to fish health or the farm operation. Siting opportunities in B.C. coastal waters are outlined based on each biophysical factor, and data gathered for this study. Where they exist, opportunities to mitigate undesirable conditions are described.

SUMMARY OF BIOPHYSICAL CRITERIA

<u>Factor</u>	<u>Good</u>	<u>Medium</u>	<u>Poor</u>
Temperature Summer:	10 - 15°C	16 - 21°C	> 21°C
Winter:	> 7°C	5 - 7°C	< 4°C
Dissolved Oxygen			
Minimum Conc :	8.1 mg/l	6.2 mg/l	4.5 mg/l
Minimum Sat. :	100%	79%	57%
Salinity			
Long Term:	> 24°/oo	15 - 24°/oo	< 15°/oo
Fluctuations:	3°/oo change	3 - 5°/oo	> 5°/oo
Plankton	No record of harmful blooms.	Infrequent harmful blooms.	Frequent lethal blooms.
Pollution	No nearby sources.	Nearby low level sources.	Within areas of high pollution sources.
Currents			
At slack water:	10 - 15cm/s	10 - 2 cm/s	< 2cm/s
At peak flows:	10 - 15cm/s	10 - 100 cm/s	100 - 200 cm/s
Depth			
At low tide:	> 50m	2 - 49m	10 - 19m
Geomorphology & Substrate	> 30° slope; rock, sand or gravel.	15 - 30° slope; sand, mixed rock.	< 15° slope; mud or organic ooze.
Hydrology	Freshwater lens depth of < 1m	Freshwater lens depth of 1 - 4m	Freshwater lens depth of > 4m
Predators	No nearby sea lion haulouts; small avian & mammalian predators.	Sea lion haulouts within 80 km; avian & mammalian predators.	Nearby sea lion rookeries & haulouts; problem predators; orcas.
Marine Plants and Fouling Organisms	Low levels of fouling organisms; no kelp.	Moderate levels of fouling organisms; kelp nearby.	High levels of fouling organisms; kelp onsite.
Wind & Waves	Sheltered site; wave height < 0.6m.	Partially exposed; wave height 0.6 - 1.2m.	Exposed; wave height > 1.2m.

TEMPERATURE*

	Good	Medium	Poor
Summer	10 - 15°C	16 - 21°C	> 21°C
Winter	> 7°C	5 - 7°C	< 4°C
	No short duration fluctuations in temperature.	Some short duration fluctuations in temperature.	Unpredictable & harmful fluctuations in temperature.
Fish Responses:			
	Good year round growth; sustained growth in winter.	Good growth but metabolic stress due to warm summer	Poor growth. Mortalities due to disease & thermal stress.

* Temperatures taken at 2m depth.

Interpretation

The optimal temperature range for culturing B.C. salmon species has yet to be determined, though it is believed that temperatures between 10 to 15°C for at least four months of the year give the best all round growth results (Kennedy, 1978). Year round ranges within 5 to 16°C are acceptable (Weston, 1986). At present, studies within the industry are being conducted to assess the merits of rearing fish in warmer water versus cooler water. Warm water temperatures (above 15°C) accelerate fish growth, decreasing the time and cost spent in getting fish to marketable size. At the same time, water temperatures approaching 21°C may cause thermal stress, and enhance incubation of disease organisms, resulting in mortalities that may greatly reduce the harvest biomass. Cool water rearing generally results in lower mortality rates, but also slower growing fish. Consequently more time and cost is involved in getting fish to the harvest stage. Fish are slowest growing in the colder winter months; 4 or 5°C being considered the minimum acceptable temperature. Temperatures below 4°C increase mortalities, and can be lethal to young fish (Kennedy, 1978).

Siting Opportunities

B.C. coastal waters provide a wide range of temperature regimes. Johnstone Strait provides cooler, well-mixed water to the areas north of Quadra Island, such as Okisollo Channel and Nodales Channel. Here,

summer surface temperatures usually average 10°C or less. Other areas such as Desolation Sound, Hoskyn Channel, and Jervis and Sechart Inlets have higher summer temperatures, which may rise above 21°C (Thomson, 1981). Sites should be selected that offer relatively uniform temperatures year round. Areas of extreme variations should be avoided: Poorly flushed, enclosed bays or inlets may suffer extreme summer temperatures; waters at the heads of fjords may undergo rapid drops in temperature due to glacial or snowmelt water discharge (see Hydrology).

Salmon have a low tolerance to temperature changes, and sites with small, predictable variations in water temperature are more preferable to areas that undergo rapid fluctuation (i.e. temperature changes greater than 5°C within a 12 hour period). Areas of rapid temperature flux may occur in warm water bays subjected to near-shore upwelling during offshore breezes (Thomson, 1981); for example, Nanoose Bay, Departure Bay, Kanish Bay and Tribune Bay. Other areas that may have rapid temperature changes are found at the mouths of inlets, where warm inlet water meets cooler channel water (e.g. Bute and Knight Inlets). Sills near the heads of some inlets may cause temperature fluctuations when cold, deep water is deflected to the surface.

Salmonid species vary in their range of temperature tolerance. Chinook salmon are the most sensitive to temperature fluctuations. Rainbow trout (steelhead) are the least sensitive to fluctuations and tolerate much greater temperature extremes. Another factor is the age of the fish: Generally, smolts and younger fish are more sensitive to temperature than older fish (Kennedy, 1978). When evaluating the temperature suitability of a site, the species to be reared should be considered.

Mitigation Opportunities

There are few methods for mitigating sudden changes in water temperature. Temperature increases can usually be dealt with by increasing the depth of the net pens so that fish can escape to the cooler water below. High water temperature can also be remedied by pumping deeper, cooler water into the seapens. To date, there do not appear to be any practical methods for warming water that is too cold.

DISSOLVED OXYGEN*

	Good	Medium	Poor
Minimum			
Oxygen			
Concentration:			
	8.1 mg/l (5.7 ml/l)	6.2 mg/l) (4.3 ml/l)	4.5 mg/l (3.2 ml/l)
Minimum			
Oxygen			
Saturation:			
	100%	79%	57%
Fish Response:			
	Few fish show symptoms of oxygen distress.	Some show symptoms of oxygen distress.	Large portion of population show symptoms of oxygen distress.
Risk to Operation:			
	No risk.	Some degree of risk if oxygen minima are prolonged beyond a few hours.	Substantial losses if oxygen minima are prolonged beyond a few hours.

*Concentration values determined at corresponding ratings for temperature and salinity (see text). saturation values derived from Davis, 1975.

Interpretation

Dissolved oxygen is the governing factor when assessing the suitability of marine sites for aquaculture. All oxygen-dependent organisms require particular minimal levels of oxygen to survive. Below these levels hypoxia and oxygen starvation occur, with concomitant ill-effects depending on the magnitude of the oxygen deficiency (Prosser and Brown, 1962).

The criteria for determining oxygen minima must take into account the nature of the exchange medium (environment), and factors that affect the availability of oxygen. For all animals, oxygen uptake is facilitated by an oxygen gradient between the blood of the organism and the surrounding medium. Oxygen requirements of aquatic animals are met by the amount of oxygen dissolved in the water. The gradient required to effect movement of oxygen into the blood is produced by a difference between the oxygen concentration in the animal's blood and the surrounding water. The degree of net movement is a function of the magnitude of the external concentration. When the concentration of dissolved oxygen in the surrounding water is greater than that of the fish's blood, oxygen enters the blood along a diffusion gradient. More oxygen diffuses into the blood per unit time when the external concentration is high (relative to the fish), and less as the external concentration decreases. At low oxygen concentrations, the fish must circulate more water over its gill membranes to obtain the oxygen it requires. The availability of oxygen in water is governed by temperature and dissolved solids (Hoar, 1975).

Dissolved oxygen concentration can be expressed in a variety of units, the most common being milligrams or millilitres of oxygen per litre of seawater (mg/l or ml/l), and percent saturation. In practice, it is preferable to express the oxygen concentration in mg/l because it is the actual amount of oxygen (mg), not its volume (ml), that is important to the fish (Hoar, 1975; Davis, 1975). The availability of oxygen in seawater is commonly analysed in terms of percent saturation (e.g. 100%). This is a function of the solubility of oxygen in water, which will vary depending on temperature and salinity. For example, at 10°C, freshwater is fully saturated (100%) when the oxygen concentration is about 11.3 mg/l. If the water were only 50% saturated it would have half the amount of oxygen [(5.6 mg/l); Davis, 1975]. Thus a body of water may be able to hold 11.3 mg of oxygen per litre, but only 5.6 mg/l are available because the water is 50% saturated.

Percent saturation is important because it reflects the magnitude of the oxygen gradient between the fish and the surrounding seawater. When water is 100% saturated with oxygen, the fish's blood can also be fully saturated. To some extent, fish can maintain their blood at 100% saturation even if the external saturation is somewhat lower due to the oxygen affinity of hemoglobin (Fry, 1957); however, there is a limit to this compensatory mechanism. Gradually, as saturation levels decrease the oxygen saturation of the blood decreases (Fry, 1957).

As temperature and salinity increase, the concentration of dissolved oxygen in seawater decreases (Davis, 1975). Of the two, temperature has the most profound affect on oxygen solubility (see Tables i-iii). Under most conditions, a 1°C change in temperature has almost 4 times the effect on oxygen solubility as a 10/00 change in salinity. A fish in warm water must pump more water over the gills than in cold water to obtain a given amount of oxygen per unit time, because of the reduced oxygen levels in warm water. Severe respiratory problems can result from

a combination of high temperature (low oxygen concentration) and low oxygen availability (water not fully saturated) (Davis, 1975).

Criteria for the minimal dissolved oxygen requirements for fish vary. One estimate gives a minimum range of 5 to 6 mg/l (Kennedy, 1978), while others report that 6 to 7 mg/l should be considered minimum acceptable levels (Weston, 1986). In both cases, the criteria were calculated on the basis of a fish's average metabolic needs, but do not establish lethal or sublethal limits. When establishing oxygen minima the lethal and sublethal effects of low oxygen (hypoxia) should be considered. Fish respond to hypoxia with a number of compensatory mechanisms and behaviours. These include increased ventilation rates, decreases in feeding and swimming behaviours, as well as biochemical changes. Over time, these responses cause stress that may manifest increased susceptibility to disease or reduction in growth (Davis, 1975). Therefore, low levels of oxygen that are above lethal levels may affect fish farm production by reducing growth rates and increasing mortalities.

The dissolved oxygen criteria given herein are based on those developed by Davis (1975) to include the levels at which sublethal effects of hypoxia occur. Davis argues that any level of oxygen that causes stress will eventually result in an increase in the mortality rate (Davis, 1975). Davis' criteria have been modified to take into account the crucial role temperature and salinity play in dissolved oxygen availability, and to more properly reflect conditions in the natural environment (Davis' criteria were established from laboratory tests under uniform conditions). Tables were constructed to calculate the availability of dissolved oxygen at various temperature and salinity regimes, using Davis' critical saturation values (see Tables i-iii). The dissolved oxygen values were determined at the corresponding ratings for temperature and salinity. For example, good temperature ratings are between 10 and 15°C in summer, and greater than 7°C in winter. Optimum salinity is above 24‰ and common salinity values for B.C. waters are about 28‰. From Table 1, the lowest value of dissolved oxygen within these ranges is 8.1 mg/l at 100% saturation. This occurs at 15°C and a salinity of 28‰. The oxygen concentration criteria given above thus account for sublethal effects, as well as reflecting the good to poor ranges of temperature and salinity. They represent minimum values for each rating, though it should be realized that actual dissolved oxygen concentrations in the environment may be higher.

As well as requiring certain amounts of oxygen, fish are extremely sensitive to changes in oxygen concentration. In general, fish are more affected by rapid, rather than gradual, changes in oxygen concentration. Fish in the wild can avoid adverse changes in dissolved oxygen simply by swimming away to more favourable areas. Fish in net pens are unable to avoid adverse oxygen conditions. Consequently, areas that are known to have sudden changes in dissolved oxygen should be avoided, unless adverse conditions can be mitigated (see below).

Dissolved oxygen levels can change dramatically as a result of plankton photosynthetic activity, upwelling of anoxic deep water, or a sudden shift in the biochemical oxygen demand (BOD) of an area (Weston, 1986). These changes can occur over relatively short periods of time. For example, a phytoplankton bloom can supersaturate an area with oxygen during the day, and severely undersaturate it at night when the organisms shift from photosynthetic to respiratory metabolism (Davis, 1975). Plankton bloom die-offs have been shown to seriously deplete available dissolved oxygen due to the increase in chemical oxygen demand (COD) associated with decay (Weston, 1986). The fish in the net pens and fouling organisms on the nets also affect the levels of dissolved oxygen. This could cause serious problems in areas where there is minimal oxygen replenishment due to poor flushing (Weston, 1986).

Salmonid species vary in their oxygen requirements. In general, salmon require higher levels of dissolved oxygen than other marine fish, probably a result of their pelagic habits (Davis, 1975). Chinook and Coho salmon have the highest requirements, and begin to show symptoms of oxygen stress when oxygen is below saturation, or less than 9 mg/l (Whitmore *et al.*, 1960). Atlantic salmon generally do not begin to exhibit symptoms of oxygen distress until the saturation drops to about 44%, or less than 4.5 mg/l (Kutty and Saunders, 1973). Steelhead require at least 64% saturation and 6 mg/l to avoid oxygen distress (Itazawa, 1970).

The age and size of the fish should also be taken into consideration. Smaller fish generally require more oxygen than larger fish to meet their higher metabolic demands (Hoar, 1975). Juvenile coho salmon appear to grow faster as oxygen levels increase: Herrmann (1958) found that juvenile coho at 20°C and 8 mg/l dissolved oxygen showed weight gains of 92%, as opposed to juveniles in 20°C and 4 mg/l dissolved oxygen, which showed only 52% gains in weight (Davis, 1975). Weight gains appear to decrease at levels above saturation (Davis, 1975), so there may be an upper limit of tolerance to dissolved oxygen.

There are a number of indications that fish can acclimate to lowered oxygen levels (Davis, 1975). Compensation, through acclimation and acclimatization, may alter the animal's critical oxygen demands (Hoar, 1975). An improved capacity to tolerate hypoxic environments has been demonstrated in a number of fish species. In general, there are two different levels at which compensation can occur; there are adjustments that enhance the supply of oxygen and adjustments that restrain its utilization (Hoar, 1975). Beamish (1964) noted that fish acclimated to 50% saturation levels performed better at this level than fish accustomed to full saturation levels. Compensation through metabolism is also well documented. Several species of fish have been shown to use more oxygen in the summer than they do in the winter, even though they are maintained at a constant temperature (Hoar, 1975). Davis (1975) considers that acclimation ability may be a built-in safety factor for species

encountering low oxygen conditions, but does not feel that there is sufficient evidence to warrant modification of oxygen criteria to include acclimatory ability (Davis, 1975). It should also be noted that acclimation occurs over days or weeks under constant conditions. The natural environment may not supply the uniform conditions necessary for acclimatization to develop.

All oxygen criteria should be considered with species-specific tolerances in mind. Most fish can tolerate short term, small magnitude changes in dissolved oxygen. When rating a site, the magnitude and duration of dissolved oxygen changes should be taken into account, as well as the species to be reared. A site that has medium year round oxygen levels may be more preferable than one at which good oxygen levels are only available for parts of the year. Also, a site with medium or poor oxygen levels may not be suitable for chinook or coho, but may be adequate for Atlantic salmon, which are more tolerant to low dissolved oxygen levels. Finally, a site poor in oxygen, but good in terms of salinity and temperature may be made suitable by aerating the water in the net pens. Oxygen criteria should not necessarily be viewed as absolute requirements, but as guidelines to choosing a site.

Siting Opportunities

Oxygen levels in coastal waters can be highly variable, both spatially and temporally. In general, tidal exchanges ensure adequate levels of dissolved oxygen to most coastal areas. Pickard (1961, 1963) provides a comprehensive study on the oceanographic characteristics for most of the inlets and channels of the mainland and Vancouver Island coasts. Large runoff inlets appear to show less variation in dissolved oxygen values along an inlet at any depth than do small runoff inlets (Davis, 1975). Supersaturation of upper layers is common and there is often an oxygen maximum at depths in which conventional fish farms operate. Small runoff inlets tend to have lowest oxygen values near the inlet head. Vancouver Island inlets show considerable variability in dissolved oxygen (Pickard, 1963). This probably relates to the high variation in temperature and salinity values recorded for these inlets.

Most coastal inlets have underwater sills at their mouths, and a few longer inlets have multiple sills throughout their length. Underwater sills change the flow characteristics of water as it enters or leaves the inlet. Combined with freshwater input, most inlets tend to show stratification of their inside waters, with dense, low oxygen water in the depths overlaid by warmer, high oxygen surface waters (Thomson, 1981). The depths at which low oxygen could become a problem vary, but for practical purposes are too deep to affect conventional fish farms, providing the strata remain stable. Problems occur when dense, low oxygen water mixes with water at the surface. This can occur in areas with active tidal flux, such as Johnstone Strait. In these areas, deep and

surface waters are well mixed, resulting in a uniform lowering of oxygen levels throughout the water column (Thomson, 1981).

Some inlets in B.C. experience seasonal fluxes in dissolved oxygen as a result of turnover. This is a common occurrence in winter, when poorly oxygenated deep water moves to the surface and displaces the well oxygenated upper layer. This phenomenon is mainly caused by differences in temperature (Thomson, 1981). During turnover, surface dissolved oxygen levels may decrease by 1 or 2 mg/l. In extreme conditions, anoxic bottom water may entirely replace oxygenated surface water causing high mortalities in some areas.

Phytoplankton can also drastically alter dissolved oxygen levels (see Phytoplankton). Recently, a plankton bloom occurred in the southern Johnstone Strait area that produced high mortalities at operating fish farms. The mortalities appeared to be caused by a sudden change in dissolved oxygen in this area (Aasen, pers. comm., 1987). Assessment of a site for aquaculture suitability should take into account the bloom history of the area.

Waste material from all sources that use the ocean for disposal, as well as the fish farms themselves, can deplete dissolved oxygen levels (see Pollution). The degree of such an effect is dependent on the frequency and magnitude of effluent discharges. Siting assessment should consider the proximity of pollution sources, including other farms in the area.

The importance of the oceanographic characteristics of an area should not be overlooked. Year round monitoring of dissolved oxygen levels should be conducted to ensure an adequate dissolved oxygen supply. Site selection should take into account the duration and magnitude of dissolved oxygen changes, as well as ensuring that oxygen minima can be maintained for most of the year.

Mitigation Opportunities

The application of good husbandry practices should mitigate short term small alterations in dissolved oxygen. The operator should ensure that net pens are not overcrowded, and the nets remain free of fouling organisms. Crowding and fouling organisms substantially increase the oxygen demands on an area. Decreasing stocking densities should be considered to overcome short term adverse conditions. Aeration by air stones or some other means can artificially elevate oxygen levels within the net pens. More drastic changes can be alleviated by pumping deeper, well oxygenated water to the surface during the summer, or by increasing the depth of the net pens to allow fish to escape from the high metabolic demand of warm, oxygen poor water. Pumping deeper water during times of plankton blooms, however, may artificially amplify the problem by supplying nutrients to the plankton. In extreme cases, it may be necessary to move the net pens to a more favourable area.

CONCENTRATION OF OXYGEN AT 100% SATURATION IN SEAWATER

(in milligrams/ litre, from normal atmosphere saturated with
with water vapour at a total pressure of 760 mm Hg)

TEMP.		SALINITY (‰)							
(C)	:	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00
4	:	11.93	11.85	11.77	11.70	11.62	11.54	11.47	11.39
5	:	11.63	11.56	11.48	11.41	11.33	11.26	11.18	11.11
6	:	11.35	11.27	11.20	11.13	11.05	10.98	10.91	10.84
7	:	11.07	11.00	10.93	10.86	10.79	10.72	10.65	10.58
8	:	10.81	10.74	10.67	10.60	10.54	10.47	10.40	10.33
9	:	10.56	10.49	10.43	10.36	10.29	10.23	10.16	10.10
10	:	10.32	10.25	10.19	10.12	10.06	10.00	9.93	9.87
11	:	10.09	10.02	9.96	9.90	9.83	9.77	9.71	9.65
12	:	9.86	9.80	9.74	9.68	9.62	9.56	9.50	9.44
13	:	9.65	9.59	9.53	9.47	9.41	9.35	9.30	9.24
14	:	9.44	9.38	9.33	9.27	9.21	9.16	9.10	9.04
15	:	9.24	9.19	9.13	9.08	9.02	8.97	8.91	8.86
16	:	9.05	9.00	8.94	8.89	8.84	8.78	8.73	8.68
17	:	8.87	8.82	8.76	8.71	8.66	8.61	8.55	8.50
18	:	8.69	8.64	8.59	8.54	8.49	8.44	8.39	8.34
19	:	8.52	8.47	8.42	8.37	8.32	8.27	8.22	8.17
20	:	8.36	8.31	8.26	8.21	8.16	8.11	8.07	8.02
21	:	8.20	8.15	8.10	8.05	8.01	7.96	7.91	7.87
TEMP									
(C)	:	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00
4	:	11.32	11.24	11.17	11.09	11.02	10.95	10.87	10.80
5	:	11.04	10.96	10.89	10.82	10.75	10.68	10.61	10.54
6	:	10.77	10.70	10.63	10.56	10.49	10.42	10.35	10.29
7	:	10.51	10.45	10.38	10.31	10.24	10.18	10.11	10.05
8	:	10.27	10.20	10.14	10.07	10.01	9.94	9.88	9.81
9	:	10.03	9.97	9.90	9.84	9.78	9.72	9.65	9.59
10	:	9.81	9.74	9.68	9.62	9.56	9.50	9.44	9.38
11	:	9.59	9.53	9.47	9.41	9.35	9.29	9.23	9.18
12	:	9.38	9.32	9.26	9.21	9.15	9.09	9.04	8.98
13	:	9.18	9.12	9.07	9.01	8.96	8.90	8.84	8.79
14	:	8.99	8.93	8.88	8.82	8.77	8.71	8.66	8.61
15	:	8.80	8.75	8.70	8.64	8.59	8.54	8.48	8.43
16	:	8.62	8.57	8.52	8.47	8.42	8.37	8.31	8.26
17	:	8.45	8.40	8.35	8.30	8.25	8.20	8.15	8.10
18	:	8.29	8.24	8.19	8.14	8.09	8.04	7.99	7.95
19	:	8.13	8.08	8.03	7.98	7.93	7.89	7.84	7.79
20	:	7.97	7.92	7.88	7.83	7.78	7.74	7.69	7.65
21	:	7.82	7.78	7.73	7.69	7.64	7.60	7.55	7.51

CONCENTRATION OF OXYGEN AT 79% SATURATION IN SEAWATER

(in milligrams/ litre, from normal atmosphere saturated with
with water vapour at a total pressure of 760 mm Hg)

TEMP.		SALINITY (/oo)							
(C)		14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00
4	:	9.43	9.36	9.30	9.24	9.18	9.12	9.06	9.00
5	:	9.19	9.13	9.07	9.01	8.95	8.89	8.83	8.78
6	:	8.96	8.91	8.85	8.79	8.73	8.68	8.62	8.56
7	:	8.75	8.69	8.64	8.58	8.52	8.47	8.41	8.36
8	:	8.54	8.49	8.43	8.38	8.32	8.27	8.22	8.16
9	:	8.34	8.29	8.24	8.18	8.13	8.08	8.03	7.98
10	:	8.15	8.10	8.05	8.00	7.95	7.90	7.85	7.80
11	:	7.97	7.92	7.87	7.82	7.77	7.72	7.67	7.62
12	:	7.79	7.74	7.69	7.65	7.60	7.55	7.50	7.46
13	:	7.62	7.58	7.53	7.48	7.44	7.39	7.34	7.30
14	:	7.46	7.41	7.37	7.32	7.28	7.23	7.19	7.14
15	:	7.30	7.26	7.21	7.17	7.13	7.08	7.04	7.00
16	:	7.15	7.11	7.07	7.02	6.98	6.94	6.90	6.85
17	:	7.01	6.96	6.92	6.88	6.84	6.80	6.76	6.72
18	:	6.87	6.83	6.78	6.74	6.70	6.66	6.62	6.58
19	:	6.73	6.69	6.65	6.61	6.57	6.53	6.50	6.46
20	:	6.60	6.56	6.52	6.49	6.45	6.41	6.37	6.33
21	:	6.48	6.44	6.40	6.36	6.33	6.29	6.25	6.22

TEMP									
(C)		22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00
4		8.94	8.88	8.82	8.76	8.71	8.65	8.59	8.53
5		8.72	8.66	8.60	8.55	8.49	8.44	8.38	8.33
6		8.51	8.45	8.40	8.34	8.29	8.23	8.18	8.13
7		8.31	8.25	8.20	8.15	8.09	8.04	7.99	7.94
8		8.11	8.06	8.01	7.96	7.91	7.85	7.80	7.75
9		7.93	7.88	7.82	7.77	7.73	7.68	7.63	7.58
10		7.75	7.70	7.65	7.60	7.55	7.50	7.46	7.41
11		7.58	7.53	7.48	7.43	7.39	7.34	7.29	7.25
12		7.41	7.36	7.32	7.27	7.23	7.18	7.14	7.09
13		7.25	7.21	7.16	7.12	7.07	7.03	6.99	6.94
14		7.10	7.06	7.01	6.97	6.93	6.88	6.84	6.80
15		6.95	6.91	6.87	6.83	6.79	6.74	6.70	6.66
16		6.81	6.77	6.73	6.69	6.65	6.61	6.57	6.53
17		6.68	6.64	6.60	6.56	6.52	6.48	6.44	6.40
18		6.55	6.51	6.47	6.43	6.39	6.35	6.31	6.28
19		6.42	6.38	6.34	6.31	6.27	6.23	6.19	6.16
20		6.30	6.26	6.22	6.19	6.15	6.11	6.08	6.04
21		6.18	6.14	6.11	6.07	6.04	6.00	5.97	5.93

CONCENTRATION OF OXYGEN AT 57% SATURATION IN SEAWATER

(in milligrams/ litre, from normal atmosphere saturated with
with water vapour at a total pressure of 760 mm Hg)

TEMP.		SALINITY (‰)							
(C)	:	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00
4	:	6.80	6.76	6.71	6.67	6.62	6.58	6.54	6.49
5	:	6.63	6.59	6.54	6.50	6.46	6.42	6.37	6.33
6	:	6.47	6.43	6.38	6.34	6.30	6.26	6.22	6.18
7	:	6.31	6.27	6.23	6.19	6.15	6.11	6.07	6.03
8	:	6.16	6.12	6.08	6.04	6.01	5.97	5.93	5.89
9	:	6.02	5.98	5.94	5.90	5.87	5.83	5.79	5.76
10	:	5.88	5.84	5.81	5.77	5.73	5.70	5.66	5.63
11	:	5.75	5.71	5.68	5.64	5.61	5.57	5.54	5.50
12	:	5.62	5.59	5.55	5.52	5.48	5.45	5.41	5.38
13	:	5.50	5.47	5.43	5.40	5.36	5.33	5.30	5.27
14	:	5.38	5.35	5.32	5.28	5.25	5.22	5.19	5.15
15	:	5.27	5.24	5.21	5.17	5.14	5.11	5.08	5.05
16	:	5.16	5.13	5.10	5.07	5.04	5.01	4.98	4.95
17	:	5.06	5.03	4.99	4.96	4.93	4.91	4.88	4.85
18	:	4.95	4.92	4.90	4.87	4.84	4.81	4.78	4.75
19	:	4.86	4.83	4.80	4.77	4.74	4.71	4.69	4.66
20	:	4.76	4.74	4.71	4.68	4.65	4.62	4.60	4.57
21	:	4.67	4.65	4.62	4.59	4.56	4.54	4.51	4.48
TEMP.		SALINITY (‰)							
(C)	:	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00
4	:	6.45	6.41	6.36	6.32	6.28	6.24	6.20	6.16
5	:	6.29	6.25	6.21	6.17	6.13	6.09	6.05	6.01
6	:	6.14	6.10	6.06	6.02	5.98	5.94	5.90	5.86
7	:	5.99	5.95	5.92	5.88	5.84	5.80	5.76	5.73
8	:	5.85	5.82	5.78	5.74	5.70	5.67	5.63	5.59
9	:	5.72	5.68	5.65	5.61	5.57	5.54	5.50	5.47
10	:	5.59	5.55	5.52	5.48	5.45	5.41	5.38	5.35
11	:	5.47	5.43	5.40	5.36	5.33	5.30	5.26	5.23
12	:	5.35	5.31	5.28	5.25	5.21	5.18	5.15	5.12
13	:	5.23	5.20	5.17	5.14	5.10	5.07	5.04	5.01
14	:	5.12	5.09	5.06	5.03	5.00	4.97	4.94	4.91
15	:	5.02	4.99	4.96	4.93	4.90	4.87	4.84	4.81
16	:	4.92	4.89	4.86	4.83	4.80	4.77	4.74	4.71
17	:	4.82	4.79	4.76	4.73	4.70	4.67	4.65	4.62
18	:	4.72	4.69	4.67	4.64	4.61	4.58	4.56	4.53
19	:	4.63	4.60	4.58	4.55	4.52	4.50	4.47	4.44
20	:	4.54	4.52	4.49	4.46	4.44	4.41	4.39	4.36
21	:	4.46	4.43	4.41	4.38	4.36	4.33	4.30	4.28

SALINITY*

Good	Medium	Poor
Long Term		
Salinity:		
>24 ⁰ /oo	15 - 24 ⁰ /oo	<15 ⁰ /oo
Short Term		
Fluctuations (within 12 hr.):		
<3 ⁰ /oo change	3 - 5 ⁰ /oo change	>5 ⁰ /oo change
Fish Response:		
Little or no osmotic stress.	Subthreshold osmotic stress due to short term fluctuations.	Incomplete smolting. Poor growth. Possible sublethal osmotic stress due to short term fluctuations.

* Salinities measured at 4m depth.

Interpretation

There are no generally accepted standards for salinity in net pen culture (Weston, 1986). All five Pacific salmonid species and Atlantic salmon have been reared to maturity in both freshwater and seawater, although seawater rearing is the preferred method (Kennedy, 1978). Consequently, it is difficult to determine the optimum salinity range for rearing net pen fish. A reasonable assumption should be that after the fish undergo smoltification, salinity optima for net pen rearing would be those approaching oceanic salinity values (28 - 30⁰/oo).

Responses to salinity vary with species and age. There is growing evidence that salinity may affect growth rates as well as survivorship in some species. Presmolt and juvenile fish generally prefer brackish water (i.e. <20⁰/oo) for the first year of development, after which higher salinities are preferred as the fish age. Young coho apparently do not adapt to seawater as well as chinook or sockeye, and all species appear to grow faster in salinities between 5 and 17⁰/oo during the first year

(Clarke et al., 1981). Young Rainbow trout (steelhead) exhibit marked reductions in growth rates at salinities above $10^0/00$ during the first year, and a salinity $>20^0/00$ is detrimental to survivorship in this species (McKay & Gjerde, 1985). On the other hand, low salinities ($<17^0/00$) have been shown to decrease resistance to toxic substances in young coho, and increase susceptibility to *Vibrio* infections in Atlantic salmon (Alderdice, 1981; Gjerdrem & Aulstad, 1974). A husbandry practice that is becoming more prevalent in the industry involves "hardening" smolts for up to 1 year in brackish water. Juvenile fish are reared in areas where freshwater runoff produces a natural freshwater lens. As the fish mature, they are gradually acclimatized to more saline water, either by moving the net pens away from the lens, or by transferring the fish to another site. This technique apparently results in hardier fish that more readily adapt to saltwater (Furby, pers. comm., 1987).

The salinity of the open ocean is generally greater than $30^0/00$. Coastal waters vary in salinity due to freshwater input from rivers and rainfall runoff. The average salinity for B.C. coastal waters is about $28^0/00$, but this will vary from region to region, and is dependent on the amount of freshwater input (Thomson, 1981).

Freshwater input creates a brackish layer that overlies the denser seawater. Brackish layers are common to most of the fiords and inlets of the B.C. coast. Such layers usually extend to about 3m depth, and vary in salinity from 1 or $2^0/00$ near the heads of inlets, to $20^0/00$ at the mouths (Gilmarten, 1958). In times of high freshwater input, such as spring snowmelts or winter rainfall, the brackish layer can extend to 10m deep or more (Thomson, 1981). Brackish layer salinities vary with the volume and frequency of freshwater input, and with the amount of saline entrainment from deeper seawater. Consequently, salinity values for coastal waters are highly variable and subject to rapid change over short periods of time.

Salinity and temperature affect the level of dissolved oxygen in the water. Oxygen is less soluble in salt water than in fresh, so the brackish layers arising from river runoff tend to be rich in oxygen while saline oceanic waters are oxygen poor. When choosing a site, the extent of mixing between brackish water and oceanic water is of prime consideration (see Dissolved Oxygen).

Siting Opportunities

The Johnstone Strait and Discovery Passage areas are seasonally influenced by oceanic waters from the Pacific. Salinities in these regions tend to approach oceanic values between 28 and $32^0/00$. Waters from the Strait of Georgia are more variable, owing to the large freshwater input from the Fraser River. Strait of Georgia salinity values are generally within the 10 to $28^0/00$ range, but these are highly variable with depth and with the season (Thomson, 1981).

Most of the major inlets undergo estuarine circulation, in which a brackish layer resulting from river and rainfall runoffs is constantly moving seaward, independent of tidal cycles (Pickard, 1961). Inlets can be classified on the basis of how much freshwater input they receive: High runoff inlets, such as Knight, Bute, Toba and Howe Sound, generally receive annual freshwater discharge rates over 200 m³/s, and vary in surface salinities between 0.1 to 20‰. These inlets are subject to annual reductions in salinity during May to September. Low runoff inlets, such as Sechart, Jervis, and Seymour, typically have runoff rates below 200 m³/s annually. Their salinities range from 1 to 29‰. Major changes in salinity occur between April and July, and during October to January (Pickard, 1961).

Mitigation Opportunities

For most sites that experience shallow brackish layers, increasing the depth of the net pens often provides adequate refuge for fish that prefer higher salinity. Where the brackish layers are extensive, pumping of deeper, more saline water can be undertaken, though some method for aeration may be required if the water is low in oxygen. Areas of freshwater lensing, such as near river mouths, may be ideal for underyearling fish.

PLANKTON

Ratings:	Good	Medium	Poor
Description:	Production of phytoplankton low. No recorded blooms (large growths) of plankton harmful to fish.	Potentially harmful levels of phytoplankton production. Infrequent reports of plankton blooms but no direct severe losses to farmed fish due to harmful plankton or due to oxygen depletion.	High risk of losses due to plankton production. Frequent lethal blooms recorded involving severe fish loss due to direct harm or to oxygen depletion.
Fish Response:	None, or minor irritation from plankton.	Some irritation and stress due to direct harm from plankton or decreased dissolved oxygen.	Irritation and stress to fish resulting in direct kills or sub-lethal effects--disease, poor growth or maturation.
Farm Operation:	Little or no effect on farm operation.	Occasional curtailment of some activities such as feeding and net changes during plankton blooms, and increase in net cleaning to reduce fouling.	Mitigative measures, if possible, are required to prevent severe fish losses. Frequent net cleaning required.

Interpretation

Organisms which are unable to maintain their distribution against the movement of water masses are called "plankton". This group includes bacteria, plants (phytoplankton), and animals (zooplankton). Generally, with a few exceptions, all plankton are small and often microscopic. Some phytoplankton and zooplankton can move themselves through the water, but movement is weak in comparison with the prevailing water movement (Parsons, Takahashi, and Hargrave, 1977).

The component of primary concern to salmon farmers is the phytoplankton. These microscopic cells (about 1/50 millimetre) use carbon dioxide and the energy of sunlight in order to grow and reproduce just as land plants do. They produce (photosynthesize) more oxygen than they use (respire)

in the daytime, but are net consumers of oxygen at night. Like land plants in temperate areas, the phytoplankton respond to the increasing spring daylight with increased productivity (spring bloom). In some cases this results in an increase of abundance coloring the water brownish green or red. A marked discoloration can also occur in the fall, but in winter lower production results in greater water clarity. Blooms intense enough to color the water surface are called red tides. In addition to light availability several other factors, including nutrients, temperature, and zooplankton abundance control the abundance of phytoplankton.

Very little is known about British Columbia phytoplankton, especially north of Vancouver Island; many of the species found appear to be similar to those located off Norway, western Japan, Chile, western South Africa, and eastern Canada (Gaines and Taylor, 1986). Generally, the phytoplankton are composed of: non-swimmers suspended in the water, the most important of which are the diatoms; and swimmers, called flagellates, the most important of which are the dinoflagellates.

Diatoms are surrounded by silica shells, often containing spiny projections. Most of the year they dominate the phytoplankton, especially in the spring when cool temperatures, high nutrient levels, and well-mixed water favour them over other groups. Consequently, the spring bloom consists almost entirely of diatoms.

While most diatoms are beneficial, the chain-forming Chaetoceros convolutus damages fish gills. This organism, often effecting lethal damage because of its spines, is found nearly everywhere in British Columbia waters, with the possible exception of protected bays and inlets where it tends to settle out of the water column. The concentration necessary for damage appears to be approximately 5 cells/millilitre (ml). This species, like other diatoms, tends to favour well-mixed nutrient-rich water (Gaines and Taylor, 1986).

Flagellates swim by means of propulsion with one or more whip-like extensions (flagella). Consequently, they can travel between well-lighted surface waters and nutrient-rich deeper water, and as a result usually dominate over non-swimmers in calm protected areas.

The flagellate of primary concern to salmon farmers is Heterosigma akashiwo which is probably found in all temperate areas of the world. Although the mechanism is unknown, Heterosigma blooms have been linked to the deaths of caged fish in a number of areas. It is a small (15-20 micrometers) potato-shaped organism with two flagella, and many mucus-producing vesicles. Closely related to well-known toxic flagellates that have killed millions of fish in Japan, Heterosigma is usually found in the upper 5-10 meters of water. It tends to bloom between May and July after the diatoms have declined, commonly causing red water in restricted areas, but less often throughout the southern Strait of Georgia.

Heterosigma can tolerate an unusually wide range of salinity (2 to 50‰), preferring a range of 15 to 20‰. Although preferring higher temperatures, it has been known to reach concentration of hundreds of millions of cells per litre below 15°C and can adapt well to low and high light intensities.

There are also a number of other phytoplankton species of concern which may prove to be a problem in the future, but have not yet been implicated in any fish kills in British Columbia (Gaines and Taylor, 1986).

Summary of Fish Impacts

There are three main types of negative impact on farmed fish from phytoplankton blooms.

1. Chaetoceros blooms can directly harm fish by damaging their gills.
2. Heterosigma blooms also can directly harm fish, possibly through toxicity, as well as causing susceptibility to disease; Rainbow trout appear to be the fish species most susceptible to harm from Heterosigma.
3. Nighttime respiration by blooms of any phytoplankton species can cause mortality or stress on fish by depleting dissolved oxygen levels. When dying off at depth due to poor conditions (such as low light), these organisms can also deplete oxygen in the water as they decompose. This latter form of oxygen reduction usually occurs at a depth where the cells reach a state of neutral buoyancy (10-30m) and remain suspended in the water column (Herlinveaux, Fisheries and Oceans Canada, Institute of Ocean Sciences, Pers. Comm. 1987).

Weston (1986) reports that salmon farms may contribute to plankton blooms by releasing nutrients into the water column.

Siting Opportunities

Because of the environmental requirements of diatoms and flagellates, there are many areas in British Columbia where problems may occur. Consequently, site choice is largely a matter of risk assessment.

In some cases this is relatively simple, because there have been reports of bloom for certain areas. For instance, harmful Chaetoceros blooms have been reported for Porlier Pass on Vancouver Island, Nanaimo, Hoskyn Channel, Calm Channel, and Agamemnon Channel/Sechelt Inlet). Heterosigma blooms have been reported for Nanoose Bay and Barkley Sound. This organism has also bloomed regularly in areas influenced by the Fraser

River northwards on the east side of the Strait of Georgia (e.g. English Bay/Howe Sound and Sechelt Inlet) with occasional spread to the west side of the Strait (e.g. Sansum Narrows). Frequency of blooms is an important consideration here. Because so many factors affect blooms, a bloom may occur in one area, and yet the likelihood of future blooms may remain very low. Only areas where blooms tend to occur repeatedly should be considered high risk areas.

In some cases, biological oceanographic literature can be of great assistance. For instance, Parsons *et al.*, (1981 and 1984) report the existence of major biological fronts, or zones of high phytoplankton production at the north end of Georgia Strait in the Hoskyn, Lewis, and Sutil Channel areas. They also report high production zones at the southern end of the Strait in the Fraser Estuary areas. These frontal boundaries of high production move with the tidal cycles as well as being influenced by the circulation.

High production is inferred in these cases from data on chlorophyll-*a*, the photosynthetic pigment found in phytoplankton. The weight of chlorophyll-*a* per unit volume or area has been correlated with standing biomass stock of phytoplankton. For instance, Harrison *et al.*, (1983) report bloom conditions in the Strait of Georgia being reflected by chlorophyll-*a* values of up to 15 mg/m³.

In the absence of written or verbal reports or biological data, it may be necessary to look at an area in terms of circulation, mixing, temperature, salinity and nutrient availability to assess the risk of bloom conditions. Smaller fronts, more localized than those described above, may occur where deep nutrient-rich water wells up within the zone of light penetration. Such areas could include turbulent passages between islands such as Active Pass, Porlier Pass and other areas in the Gulf Islands (Parsons *et al.*, 1981), shallow sills such as Skookumchuk Narrows, and upwelling areas in bays, such as Nanoose Bay.

Where mixing and flushing are low in stratified bays and inlets, phytoplankton production may be reduced or not sustained because of rapid nutrient depletion (assuming no significant source of nutrients such as sewage discharge, landwater runoff, or other fish farms).

Unfortunately, prolonged stratification may result in other conditions undesirable for fish farming such as stagnation and oxygen depletion at depth, and subsequent oxygen depletion of the surface.

Mitigation Opportunities

Mitigation measures must be geared to the agent causing bloom conditions as well as to the nature of the harm being done. Unfortunately, it is not always possible to determine the cause at all or in time to reduce

the impact. For instance, the mechanism by which Heterosigma causes damage is not clearly known.

In many cases, husbandry practices can significantly contribute to the degree of damage caused, or how much damage is avoided. It is not uncommon for a bloom to occur in an area, with significantly different losses being encountered among different farms in the same area.

The first step of problem solution is to notice the problem before it causes much damage. The best way to accomplish this is routine monitoring of water conditions. Daily secchi disc readings give some idea of decreased light penetration caused by plankton blooms. However, these readings are of light penetration only and therefore can be confusing if affected by other factors such as increased water turbidity due to spring freshet and increased landwater runoff.

A more certain way of monitoring phytoplankton is to take water samples and do microscopic examinations and cell counts on a routine basis. A good frequency would be biweekly between early March and mid-September, with daily sampling and analysis if secchi readings begin to decrease. This is especially necessary to detect Chaetoceros which can form blooms within a week (Gaines and Taylor, 1986).

Several general practices can help reduce the damage caused by blooms. These include maintaining low stocking densities, and keeping the nets clear of fouling material. During a recent Chaetoceros bloom, farms stocking at 4 kg/m³ experienced significantly fewer losses than other farms stocking at 12 kg/m³. Also, it appears that if the nets are fouled, the oxygen demand of the fouling material coupled with the reduced flow through the nets makes oxygen depletion worse.

Deep nets may be effective in areas where Heterosigma blooms are likely, since these organisms generally favour the upper 5-10 m of water. However, there have been cases where Heterosigma blooms are distributed to quite deep levels, such as in the Agamemnon Channel in 1986. Where Chaetoceros blooms are likely, increasing net depth will probably not be effective because of the deeper nature of these blooms in well-mixed waters.

Pumping water into the nets from very deep levels has been considered as one mitigative tool to flush the pens. However, this can cause additional problems when the deeper water is low in oxygen. Further, deeper waters might also be high in nutrients and as a result increase or prolong the plankton bloom.

Ware(pers.comm.,1987) reports successfully dealing with a Chaetoceros bloom by pumping fresh water onto the surface of new smolts pens, while wrapping the pens with a tarpaulin. This technique may help control Heterosigma

blooms, although the organism's salinity tolerance should be taken into account. Of course, this approach necessitates a ready supply of fresh water.

POLLUTION

ings:	Good	Medium	Poor
cription:	Area is outside the environmental influence ¹ of industrial, municipal or local sources of pollution. Debris absent or rarely present.	Area is within the environmental influence ¹ of low continuous levels or rare periodic discharges of pollution. Sporadic debris (major storms).	Area is within the environmental influence ¹ of severe pollution (significant change in background levels of water quality characteristic). Areas within 100 m of outfall or diffuser are unacceptable ² . Prolific presence of debris on almost daily basis.
Fish Response:	None.	No known or measurable harm.	Mortalities; tainting of flesh; sub-lethal effects such as abnormal growth; accumulation of toxic materials; higher incidence of infection.
Farm Operation:	None.	Minor cleaning of equipment and nets. No mitigation of fish impacts required.	Continuous maintenance problems. Mitigative action required.

¹ Influence means there is a measurable change in ambient water quality caused by the pollution.

² Policy of B.C. Waste Management Branch is that areas 100 m downstream or within a 100 m radius of a municipal/industrial outfall or diffuser are considered dilution zones. Discharges must meet ambient water quality objectives by the end of this dilution zone.

Interpretation

The main types of pollution which can affect salmon farms are:

1. toxic, which has a poisoning effect on fish;
2. organic, which can deplete water column oxygen;
3. nutrient, which stimulates growth of algae (these can deplete water column oxygen, and some species harm fish);
4. acid, which changes ambient pH and affects toxicity of some pollutants;
5. sediment, which may clog or harm fish gills;
6. thermal, which alters the temperature of the ambient environment; and
7. debris, which clogs or damages nets and farm structures, and can exert a biochemical oxygen demand of the water column or sediments.

Pollution sources include: industrial and municipal effluents; discharges from anchored and passing boats; debris from logged watersheds or log-handling areas and log-towing operations; accidental spills from transport vessels (e.g. oil tankers); upland runoff contaminated with sediment or toxic substances (pesticides, oils, solvents, wood preservatives, cleaners, fertilizers); and cumulative impacts from other fish farms.

The negative impact might range from rapid mortality to long-term sub-lethal (lower resistance to disease, abnormal growth and maturation) in addition to tainting of fish flesh, and accumulation of chemicals and metals hazardous to humans.

Many of these discharges comprise several kinds of pollution. For instance, a municipal sewage discharge might contain the toxic, organic, and nutrient pollution, whereas a mine discharge may contain toxic, acid, nutrient, and sediment pollution.

There can also be negative effects on farm operation in terms of increased attached growth on nets (sliming) due to nutrient loading from a variety of sources, damage of nets or walkways by floating debris, or reduced visibility in water due to sediment or phytoplankton.

Most direct industrial and municipal discharges (point sources) such as sewage, mine, and pulp mill effluent are documented and, whether continuous or intermittent, must be permitted by the Provincial Government. The Waste management permits specify waste quality standards to be met by the permittee, as well as objectives for environmental quality which must be maintained. Information on discharges under permit

is available from the Regional Waste Management Offices (Ministry of Environment and Parks [MEP]). The Environmental Protection Service (EPS) (Environment Canada) has the regulatory responsibility for ocean dumping. All the existing dumping sites have been documented.

Diffuse (non-point) discharges such as landfill leachate, sewage from marinas and boats, toxic spills, and upland runoff may be intermittent or continuous and may not be documented. Careful examination of various activities such as solid waste disposal, logging, boat transportation, and marina location will be necessary to assess the risk of non-point discharges and concomitant pollution occurring in an area. Federal fishery officers and Provincial conservation officers can provide useful information on coastal activities in this context.

A new potential source of pollution in British Columbia is the marine fish farm itself. Unused food and faecal wastes can contribute significant amounts of nitrogen compounds to the water, possibly enhancing plankton production at the site, and also organic carbon to the sediments which can cause oxygen depletion problems (Weston, 1986). Sediment anoxia can result in production of hydrogen sulfide gas which is toxic to fish. This impact is usually specific to fish located at the site.

A coastal system may have the capacity to assimilate waste loadings because of tidal dispersal and current mixing. Also, in time, sediments at a site will return to normal once the waste loading ceases. Nevertheless, cumulative impacts might occur where several large-scale farms are located in poorly exchanged waters such as some coastal inlets, channels and bays. The Ministry of Agriculture and Fisheries (MAF) can provide assistance with regard to calculating waste loadings from various sizes of farms.

Fish farms can also cause a form of aesthetic/fish health pollution. Every farm experiences mortality of a variable percentage of its salmon stock ranging from about 10 to 40%. If these fish are disposed of by throwing them into the water outside the pens, they can wash up on shore creating undesirable sight and smell, in addition to being a means of disease transmission to wild or other domestic salmon stock. Burial of the dead fish in a lime pit or incineration will avoid such problems, and the complaints which accompany them (contact MEP or MAF regarding this).

Siting Opportunities

Over 70% of British Columbia's population resides on or near the coast of the Strait of Georgia. This strait serves as a receiving water for many of the Province's industrial and domestic liquid waste discharges. Also, because of upstream waste loadings, the Fraser River is a major contributor of various pollutants. Fortunately, except for localized areas, water quality in Georgia Strait is fairly good, because of the

degree of renewal with water from the open ocean via Juan De Fuca Strait (Thomson, 1981).

To date, most farm sites have been located in remote, relatively pollution-free regions of Georgia and Johnstone Straits as well as other areas such as Sechelt Inlet and Barclay Sound. These areas are removed from the major estuaries, such as Squamish, Fraser, Nanaimo, and Cowichan where the majority of the Province's industries are located, and which are generally not suitable for salmon farming because of depth, salinity or current not being acceptable.

Inlets on the east side of the Strait of Georgia, such as Howe Sound and Burrard Inlet, that receive direct industrial or municipal discharges may, at certain times of the year, have poor localized water quality. These areas should be generally avoided. Of course, there may be a few isolated locations within these areas which are acceptable. On the west side of Georgia/Johnstone Straits, several major discharge plumes from pulp mills at Crofton, Nanaimo, and Campbell River should also be avoided. Pulp mill discharge areas at Port Mellon in Howe Sound, and also at Powell River, should be avoided. The nature and extent of these zones are generally well-documented by environmental agencies (EPS, MEP).

Some other areas, such as Rupert Inlet and Alice Arm, are the sites of mine waste disposal. While the effects of these wastes on pelagic Biota are uncertain (Waldichuk and Buchanan, 1980) caution is advised with regard to siting salmon farms within tailings plumes.

Also, throughout B.C. coastal waters, one should be careful in considering abandoned log-handling sites. These areas may have been disturbed recently enough to result in release of toxic wood waste components or sulfur dioxide gas from thick deposits of decaying wood bark. A dive survey can assist in an assessment of substrate conditions.

Locating a farm in the vicinity of marinas increases the likelihood of harm from cleaning bilges, dumping cleaning solutions, gas and oil discharges, spills, or contamination by antifoulant paints.

When assessing the suitability of a site in the vicinity of a community or population, care should be taken to avoid locations of both point and non-point sewage discharges, such as outfalls or malfunctioning sewage disposal systems. Local Public Health Inspectors (Ministry of Health) can provide information on areas prone to malfunctioning systems.

Assistance in assessing the potential impacts of various wastes on a potential fish farm can be obtained from EPS, Fisheries Branch (MEP) and the Aquaculture and Commercial Fisheries Branch (Ministry of Agriculture and Fisheries). In many cases, the information available has been obtained from reports on experiments using salmonids under controlled conditions in the presence of various pollutants.

Important considerations in siting salmon farms are water quality criteria and objectives -- the definition of "criterion" used by the Water Management Branch (MEP) is as follows:

"A maximum and/or a minimum value for a physical, chemical, or biological characteristic of water, sediment, or biota, applicable province-wide, which must not be exceeded to prevent specified detrimental effects from occurring to a water use, including aquatic life, under specified environmental conditions."

The MEP is currently developing general water quality criteria on a province-wide basis. These criteria will form the basis for water quality assessments, or the preparation of site-specific objectives. At present, general marine criteria exist for cyanide and nitrogen for British Columbia, and no objectives (site-specific ranges) exist. Until B.C. criteria and objectives for salmon exist, the prospective farmer is advised to consult U.S. EPA for advice on investigating an area which may be subject to the influence of a particular type of pollution. Advice on what water quality data are available for a specific area, and how to compare those data with water quality criteria can be obtained from the Resource Quality Section of the Water Management Branch (MEP).

A convenient rule of thumb one can use in the absence of water quality criteria is to avoid areas upon which shellfish closures have been imposed by Fisheries and Oceans Canada because of pollution (Waldichuk, Fisheries and Oceans Canada, Pers. Comm., 1987).

Siting pens in areas of good current helps to distribute farm-produced organic waste over a larger area. This decreases chances of overloading the natural ability of bottom animals to break the waste down to a stable form with a low oxygen demand. Areas with high flushing potential such as open bays have a greater potential for diluting and removal of any nutrients. Consequently, such areas are less prone to increased plankton blooms than enclosed low-flush areas such as the heads of inlets (Gowen et al., 1985).

Mitigation Opportunities

Impermeable skirts around seapens can be used to avoid the effect of accidental surface contamination from a toxic chemical or an oil spill. Pumping of deep, clean water into the seapen would also help disperse pollutants. For prevention purposes, it is worthwhile to inform boaters encountered of the sensitivity of farmed fish to bilge waters, cleaning solutions, oil, and gas. These measures are directed more to accidental or spontaneous pollution occurrences. The best way to avoid continuous pollution is to select a site in a better location.

The employment of a feed fine recovery system will reduce organic and

nutrient loading from the farm to the environment. Fine removal will also help avoid the decrease of dissolved oxygen in the pens frequently noticed after feeding (Weston, 1986). Pen movement can be used to spread waste accumulation over a greater area and allows time for biological degradation of the organic sediments in those areas from which the pens have been moved (fallow areas). Orienting the pens so that the largest surface area is exposed to the current will also distribute the organic material over a wider area.

CURRENTS*

	Good	Medium	Poor
At Slack Water:			
	10 - 15 cm/s	10 - 2 cm/s	<2 cm/s
At Peak Flows:			
	10 - 15 cm/s	50 - 100 cm/s	100 - 200 cm/s
Current Regime:			
	Even currents throughout tidal cycle.	Short periods of slack water during tidal cycle.	High variability in current speeds during tidal cycle.
Fish Response:			
	No adverse symptoms.	Greater effort required to capture feed and maintain position during peak flows.	Stress from fast currents at peak flows, and oxygen distress during slack water.
Effect on Operation:			
	No adverse effects.	Alteration of feeding schedule during peak flows. Minor reduction in usable volume of net pens.	High feed losses. Frequent net cleaning. Reduction of usable net volume. Anchoring problems.

*Measurements at 5m depth.

Interpretation

Currents play an important role in fish farming. Adequate currents are required to exchange water through the net pens, and to disperse waste feed and fecal material (Weston, 1986). In general, a flow of at least 10 cm/s outside of the net pens is desirable throughout most of the tidal cycle (Kennedy, 1978). Although occasional and short-term decreases in current speeds are acceptable, sites with consistently low flows should be avoided (Weston, 1986).

On the other end of the scale, excessive current flows will distort the sides of the net pens, reducing the usable volume and causing stress to both the fish and the anchoring system (Weston, 1986). Some authors suggest that maximum current flows in the range of 50 to 100 cm/s should be avoided (Kennedy, 1978), while many in the industry feel that speeds above 200 cm/s are the maximum range.

When choosing a site, the effect that the net pen facilities on current flow must be taken into account. Net pens will produce a wake, which will alter the current patterns and speeds in the vicinity of the facility. Within the net pens themselves, reductions in current speeds to 35 - 81% of the upcurrent velocity have been reported (Weston, 1986). The degree of current flow reduction depends on the configuration of the facility, the amount of fouling on the nets, and the number of fish stocked.

Reduction of current speeds could potentially promote sedimentation of suspended particulate matter or enhance degradation of water quality as a result of poor flushing. This could become significant under certain conditions, such as a high density of units in a bay with very restricted natural circulation (Weston, 1986). Reduction of current speeds could prevent adequate supplies of oxygenated water and inhibit removal of metabolic wastes. One study found that chinook salmon experienced heavy mortalities when fouling of the net prevented adequate water exchange. Dissolved oxygen concentrations dropped as low as 2 mg/l inside the pens, while concentrations outside the pens were 6.5 to 9 mg/l (Weston, 1986).

Siting Opportunities

Coastal currents are caused by tides, winds, freshwater runoff and wave induced transport (Landless and Edwards, 1976). Wave action (except for the effects of swell) is probably the least important factor in current generation. Tides have the most predominant and persistent effect on current speeds. A general picture of expected tidal currents can be obtained from navigational charts of the area, tide and current tables, and current atlases. In practice, considerable variability is found near irregular topographic features. Eddies occur in the lee of points, in bays, and over irregular bottoms; because of this variability, atlas information should always be supplemented with a site survey (Landless and Edwards, 1976).

The range in tide heights for the B.C. coast averages 3 to 5 m, with greatest amplitudes occurring during June and December and lowest amplitudes in March and September (Canadian Hydrographic Service, 1987). These changes in the height of water generate tidally induced currents, the magnitudes of which vary with the change in tide height, and the geomorphology of a particular area (Thomson, 1981). Measured speeds vary from 52 cm/s in the open ocean to maxima of 800 cm/s (16 knots) at Natwakto Rapids in Seymour Inlet (Thomson, 1981).

Currents along the B.C. coast are also affected by freshwater runoff; this is particularly true of large runoff inlets such as Howe Sound. In these inlets a surface layer of low salinity water, fed by rivers, covers the deeper, more saline water. This upper layer has a net movement seaward. The magnitude of the surface current depends on the rainfall and consequent runoff; the seaward flow always augments the ebb tide and diminishes the flood, and can on occasion be so marked as to reverse the surface flood, in which case surface water shows a constant ebb (Landless and Edwards, 1976).

Wind also exerts stress on surface layers. Surface current speed can be 1 to 5% of windspeed (Landless and Edwards, 1976). This could pose problems to fish farmers, especially in areas where the water is stratified and there is poor tidal mixing. In summer, warm surface water could be wind-driven by onshore breezes onto fish farms.

On site current measurement by the use of current meters or drogues is a prudent step in site selection. Measurements should be taken throughout a tidal cycle to account for the different current rates at spring and neap tides. The measurements should also be taken at various depths to determine the extent of countercurrent velocities in areas of high stratification. Most current measurement should be taken at about one-half the total depth of the net pens, or about 5 m. The direction, as well as its speed, should be determined.

Mitigating Opportunities

Operators can take several measures to minimize the effect of the facility on water circulation. In strong currents, multiple pen arrangements should be oriented parallel to the direction of water flow. This would minimize alteration of water circulation and simplify anchoring requirements under weak current regimes, the facilities would be better arranged perpendicular to the current flow to increase the waste disposal area and ensure maximum water exchange in the net pens (Weston, 1986). Regular cleaning of nets will alleviate drag and deformation of the net pens in high current flows, while ensuring adequate replenishment of oxygenated water. Increasing the mesh size can also enhance water circulation. A 5 cm mesh size has been shown to decrease the current velocity inside net pens by up to 60%, while a 2 cm mesh reduced the current flow by 70% (Weston, 1986). These measurements were made before appreciable fouling organisms had built up. Stocking density is also a factor, as the number of fish per pen will have a profound effect on current flow.

During times of fast current flow (i.e. between 50 and 100 cm/s) the feeding regime will have to be adjusted to reduce feed losses. Feeding could also be curtailed during prolonged periods of slackwater to minimize sedimentation of waste feed.

Natural circulation in areas of low current flow may be enhanced by artificial means. The use of large, underwater propellers to increase current velocities at net pens is currently being investigated in Norway (Litaca, pers. comm., 1986).

SITE PHYSIOGRAPHY
(Water Depth (metres), Geomorphology and Substrate)

Ratings:	Good	Medium	Poor
Chart Depth (at low tide):	50 - 100 m	20 - 49 (seapens) 100 - 150 (anchorage)	10 - 19 (seapens) >150 (anchorage) (less than 10 m is unacceptable unless the current is very strong)
Geomor- phology/	Bedrock or boulder inter- tidal zone at steep (>30°) slope; can use stiff legs on- shore; boulder, gravel or sand sub-tidal sub- strate at gentle slope (<30°), good for use of anchors.	More gently sloping Gentler (15-30°) bedrock or boulder intertidal zone, with sand or mixed rocks; stiff legs not feasible.	Very gently sloping (<15°) gravel on mud intertidal zone; sub-tidal zone of mud and/or organic ooze; stiff legs not feasible.
Farm Operation:	Anchoring close to shore with- out having to anchor farther out in exposed water to reach a desirable depth; no bottom accumu- lation of or- ganic wastes; no likelihood of damage due to slope failure.	Extra anchoring required because of unstable substrates. Pens must be located farther from shore for suitable depths; some organic waste accumulation on bottom; small prob- ability of damage from slope failure.	Difficulty in anchoring. Excessive waste accumulation. Fallow area for dispersal of wastes required; high probability of damage from slope failure.
Geomor- phology/ Shoreline Stability:	No shoreline instability above or below water; no signs of slumping, rockfalls, avalanches, or debris flows.	Isolated evidence of instability, above or below water; some slumping, rockfalls, avalanche zones or debris flows.	Shoreline known to be unstable above or below water; surface slumping, deltas, rockfalls, avalanche zones or debris flows abun- dantly evident.

Note: Chart depths less than 10 metres are not considered acceptable. ratings based on assumed tidal current of 5 cm/s and farm production of 100 tonnes (maximum biomass on site). Slower currents and/or higher production require greater depth.

Interpretation

Water depth is considered important for two purposes:

1. Sufficient depth is necessary for satisfactory dispersal of waste food and faecal material, as well as isolation of this material from the fish in the pens (see: Pollution); and,
2. The farm must be located in an area which is not too deep for suitable anchorage at an acceptable cost.

Greater depths improve natural biological degradation as feed and faecal particles slowly sink to the bottom. However, less depth is required if tidal currents are sufficient to disperse wastes. About 5m less depth is required for every 10 cm/s increase in mean current velocity up to a velocity of about 50 cm/s (Science Applications International Corporation [SAIC], 1986). At any velocity greater than this, the depth should be at least 20 m for a site of medium suitability. The above depth ratings were based on experience with the salmon farming industry as well as a review of SAIC (1986).

Geomorphology of an area is important from the perspective of flushing and removal of nutrients from an area, as well as anchorage and farm safety. It is also important for understanding oceanography of an area primarily in terms of dissolved oxygen concentrations, but also from the perspectives of temperature and salinity.

Shallow sills have a tendency to restrict inflow of seawater from outside to deeper levels of inlets. The result can be poor renewal at depth, in some cases for a major portion of the year, resulting in stagnation and deoxygenation. In winter, smaller inlets reach uniform temperature from top to bottom, and then circulation and mixing of deeper, poorly oxygenated water causes surface dissolved oxygen levels to plummet. An example of this is the Saanich Inlet (Thomson, 1981). In larger inlets, dense, cold, deep water from outside the inlet can well up over the sill in winter, sink and then force stagnant, deep inlet water to surface at the head. An example of this is the Sechelt Inlet (Lazier, 1962). There are also special cases such as the Rupert/Holberg Inlet system which experiences seasonally low dissolved oxygen levels in late summer/early fall. This occurs because a rapid density current dives down the inside of the sill, and actively mixes poorly oxygenated water throughout the water column (Truscott, 1987). The result in all these cases is an environment with lower dissolved oxygen levels than are desirable for salmon farming.

The criterion for sill depth used for the ratings above is based on a review of sill depths and the thickness of the brackish surface layer in inlets which experience estuarine-type circulation. If the depth of the sill is equal to or less than the thickness of the brackish surface

layer, stagnant conditions result, with a marked restriction in the flushing of the fjord (Gilmartin, 1962).

Enclosed bays or inlets also experience decreased flushing by the tide. This is because in most deep estuaries, high and low tides occur virtually simultaneously throughout the length of the fjord, suggesting that tides act primarily as a pulse at the mouth. Indian Arm provides a good example of this kind of pulse effect (Gilmartin, 1962).

- Unstable upland slopes are common along the B.C. Coast, given its rugged physiography. A variety of factors affect the stability of slopes (Sharpe, 1938) including:

- slope angle;
- geological processes operating in an area (glaciation, vulcanism, earthquake activity, springs, snow and rainfall, wind, movement of crustal plates, and waves);
- presence or lack of vegetation;
- human activities such as deforestation, railroad and road building, and mining;
- natural agents such as tides, thunder, fires, heating, cooling and drying.

With the abundance of unstable slopes comes the likelihood of damage or destruction to a farm, if located in an area prone to mass wasting (land/mud slides), avalanches, slumping, or debris flows down creeks or slopes. Upon failure, unstable submarine slopes can cause loss of anchorage or submergence of the farm if the anchors are heavy enough and move far enough downslope. Slope failures can occur slowly or often very rapidly leaving little or no time for escape.

Siting Opportunities

Due to past glacial activity and the rugged nature of the British Columbia Coast, there are many potential sites with sufficient depths for salmon farming within a few hundred metres of the shoreline. The majority of sites under application reflect this potential. Even in very deep fjords and channels, siting in water of adequate depth is possible through use of stifflegs attached directly to a rocky, convoluted shore.

Mouths of streams and rivers where marine deltas are present, such as at the heads of inlets, tend to offer depths in the "poor" category. These areas also tend to be poor for other reasons such as upwelling of low dissolved oxygen-containing water, low temperature, and decreased salinity.

Quite a lot of information has been documented on causes of slope failure, and also terrain mapping for British Columbia. From the foregoing

discussion it will be obvious that the potential salmon farmer should become aware of possible slope stability problems in an area under investigation, and simply avoid problem areas. Terrain and soil-land form maps are available from Maps B.C., Ministry of Environment and Parks (MEP), Victoria, B.C., V8V 1X5. All published maps and reports are listed in the Division Catalogue available at the same location. An excellent and essential booklet for interpreting these maps was prepared by Ryder and Howes (1984), also available at the above location. Information on slope stability assessment can be obtained from MEP, Fisheries Branch, Habitat Management Unit, Victoria (above water) and Energy, Mines and Resources Canada, Pacific Geosciences Center, Sidney, B.C. (marine).

When planning or assessing a farm site, area bathymetry, slope, and stability should be studied in order to determine anchoring specifications and cost. This can avoid problems such as anchors rolling or sliding down a steep or unstable slope.

Mitigation Opportunities

Other than choosing a better location, the only practical way of dealing with insufficient depths is to use shallower net pens, thereby increasing the depth below the pens. Unfortunately, this can create a new set of problems such as eliminating potential deep water refuge for the fish from high temperatures or reduced surface salinities.

Because of the magnitude of potential problems where unstable slopes are found, there is virtually no way to mitigate such problems.

HYDROLOGY (Study of Freshwater Flow)

Ratings:	Good	Medium	Poor
Description:	A small source of freshwater which will not rapidly alter salinity or water quality. A small source (stream or well) is present for potable water.	Seasonal run-off or freshets that rapidly change salinity or water quality to a limited extent (5 to 10 cubic metres per second [m^3/sec] stream discharge)	Flash flooding accompanied by silt or debris. Rapid change in salinity to a large extent.
Fish Response:	No stress to fish.	No or minor short-term stress to fish.	Severe stress to fish and impacts to farm structures.
Depth of Freshwater Lens:	< 1 metre	1 - 4 metres	> 4 metres
Change in salinity > 50/00, or in temperature > 5°C within:	24 hours	24-12 hours	< 12 hours

Interpretation

The above ratings pertain primarily to rapid and significant changes in salinity, dissolved oxygen, and temperature due to local freshwater runoff events such as freshets and severe storms. These criteria were based on actual stream discharge data from three different sources and their effect on the marine environment in terms of depth and areal extent of the freshwater lens.

Discharges from streams in British Columbia are quite variable. Many small streams exist, discharging maximum volumes of less than $5 \text{ m}^3/\text{second}$ at any time, and may in fact run dry during part of the year. Some streams, while dry at times, experience sudden large peak flows during storm events which would be undesirable from a salmon farming perspective. At the upper end of the range are major rivers, the largest of which is the Fraser. In an average year the Fraser discharges a peak

flow of about 10,000 m³/sec. (Wyman, B.C. Ministry of Environment and Parks [MEP], Pers. Comm., 1987). The Squamish River, although smaller, still has a substantial discharge with a normal peak flow of 760 m³/sec in the early summer, and abnormal peaks in the order of 2100 m³/sec (Thomson, 1981).

From a hydrological perspective, farm sites are most suitably located in areas of low relief, well away from mountainous areas that are subject to a high degree of precipitation, or outside the influence of runoff from large watersheds. Some areas of steep relief are subject to a lot of precipitation, such as the west coast of the Queen Charlotte Islands. The result is sudden storm events, runoff peaks, and slope failures -- especially in heavily logged areas (Poulin, 1986). Runoff in these areas is above average in the winter and spring, and below average in the July - September period, following the coastal rainfall pattern. Areas with large watersheds, such as Knight, Bute, and Rivers Inlets, experience large runoff due to snowmelt in the May - July period with a secondary maximum in October (Pickard, 1961).

High runoff areas release large amounts of fresh water to either a localized area (small watershed, steep terrain situation) or over a large area (large watershed situation). Because freshwater is less dense than seawater, it tends to float on the saltwater, mixing with it only very slowly. Consequently, a brackish layer may exist to a depth of several meters over a large geographical area such as occurs in Howe Sound due to runoff from the Squamish River (Thomson, 1981). Another instance would be Knight Inlet runoff, which is noticeable as far down the coast as Calm and Sutil Channels (Pickard, 1961).

Often, silt and debris are associated with runoff from sudden storm events. This adversely affects water quality, in addition to causing rapid changes in salinity. Temperature can also drop dramatically if the runoff is from melting glaciers and snowpack. These effects are most noticeable close to the discharge point, and because of gradual dilution due to entrained seawater, become less pronounced farther away. The larger the runoff is, the more noticeable and widespread the effects will be.

Coastal inlets with small watersheds, such as Seymour, Belize, and Sechart tend to be less of a problem due to lower runoff (Pickard, 1961).

Generally, salmonids are more tolerant to sustained salinity and temperature regimes than to rapid changes in those variables. Immediate fish mortality may not occur from sudden changes, but sub-lethal, latent effects may manifest as disease outbreaks, reduced growth, and incomplete smoltification.

A moderate source of freshwater can be used to advantage to facilitate smoltification (see: "hardening" in Salinity). This is accomplished by

pumping freshwater into a seapen wrapped with a tarpaulin. The resulting salinity gradient allows the fish a choice of salinity. Such an approach has also been used recently to avoid fish mortalities from Chaetoceros blooms (see: Plankton).

Siting Opportunities

In assessing the suitability of a site for salmon farming, the prospective farmer should examine available long-term data from streams and rivers in the area, as well as salinity/temperature profiles at the proposed site over a one-year period to determine seasonal changes in marine surface-water caused by regional runoff. One can estimate average discharges from streams by calculating the size of drainage basins on maps and by determining volume per unit area of precipitation in the area. The likelihood of extreme events cannot be assessed using this method. Discharge data from some areas are available from Environment Canada - Water Survey of Canada. Precipitation data can be obtained from Environment Canada - Atmospheric Environment Service. The Surveys and Resource Mapping Branch (MEP) sells topographic maps of the province. Actual stream discharge data are preferable because such measurements give more accurate estimates of hydraulic loading than are available from precipitation data.

Mitigation

Where sites have only 1-2 metres of freshwater on the surface, use of deep nets will provide some refuge for the fish, providing there is no dissolved oxygen depletion problem at depth. Sites which experience rapid temperature and salinity changes to depths greater than 3 or 4 metres offer no effective means to avoid impacts on fish. Where changes are moderate, selection of more tolerant species of fish such as rainbow trout is advisable. Damage to the farm from debris can be avoided by constructing booms and debris nets.

PREDATORS

Ratings:	Good	Medium	Poor
	No indigenous predators; rare migrants; minor protection measures needed.	No indigenous predators, but indigenous population close enough for them to be in the area frequently (within 80km.). Readily manageable.	Predator colony/ population lives very near the site; site on migration route; common presence of predators and predation problems; protection measures and constant vigilance required to prevent serious fish loss.

Interpretation/Siting Opportunities

A variety of animals which prey upon salmonids are found in B.C. coastal waters. These include seals (Harbour, Fur), sea lions (Steller, California), dogfish, heron, kingfisher, seagulls, otter, and mink. It is virtually impossible to find an area without the presence of one or more of these predators. However, it is not advisable to locate near a colony, such as a sea lion haulout (i.e. within 5 km).

Seals and sea lions can be a major problem by pushing poorly hung predator nets against the sides of a salmon pen, and biting through the mesh. The B.C. Provincial Museum can provide information on seal concentrations and haulouts. Bigg (1985) provides information on rookeries (mating areas), haulouts and winter sites (rocks) and rafting sites (transitory floating accommodation) for Steller and California sea lions.

Dogfish are also bothersome predators. If predator nets are not used, or are carried close to the pens, by the current, dogfish can bite fish through the meshes of the pen. Federal Fisheries Officers for the various regions can provide information on dogfish concentrations.

River otters, which are common throughout B.C. coastal waters, have a tendency to get into the growout pens and bite the fish. In addition to direct mortalities, this can create extra stress for the fish. The Wildlife Branch (MEP) has information on their distribution.

Water birds (e.g. heron, kingfishers, and seagulls), waterfowl (e.g. mergansers, cormorants), and birds of prey (e.g. eagles, hawks, ospreys)

also cause other mortalities and damage to fish by capturing them or pecking at them.

Both grizzly and black bear can threaten the farmer as well as the farm operation. Disposal of dead fish on land can aggravate this threat since bears' keen sense of smell will often enable them to locate fish carcasses. With a potential continuing supply of food, bears will be motivated to frequent the fish farm area.

The regional conservation officers (MEP) can provide advice on proper disposal procedures, fencing of both the disposal site and the farm, and bear distribution. Grizzlies are common at the heads of inlets and in stream areas, particularly during salmon migration. Black bears are common to most wild areas along the coast, including islands.

There is no current evidence that killer whales are likely to be a problem to salmon farmers, despite the fact that salmon is a preferred food item. Neither has there been any account of killer whales interfering with commercial seine fishing operations in the Johnstone Strait area, which is a whale migration route.

Mitigation Opportunities

The best mitigative measure is to avoid siting in areas rated as poor. Destruction of wildlife is legal only when authorized under the Wildlife Act or the Migratory Birds Convention Act. If a predation problem results, it is the policy of the B.C. Ministry of Environment and Parks to issue permits to destroy wildlife only when the farmer has made all reasonable efforts to minimize the attraction of the animals.

Marine animals, such as seals and sea lions, fall within the jurisdiction of the Federal Department of Fisheries and Oceans. Section 21 of the British Columbia Fishery (General) Regulations prohibits the killing of any marine animal except under licence.

The following guidelines will help to ensure that aquaculture operations are predator proof.

1. Waterbirds, Waterfowl, and Birds of Prey

Aquaculture operations should be covered with netting that:

- i) has a mesh size small enough to prevent the birds from penetrating it, and
- ii) is made of a gauge heavy enough to be clearly visible to the birds and to prevent them from becoming entangled in it.

These apply to nets used for both above water and under water protection. Spaced white string over nets can deter birds as well.

2. Furbearers

Aquaculture operations should be designed and managed to minimize the attraction of furbearers. This could take the form of netting that:

- i) is of a size that will not permit animal entrance, and
- ii) is made of a gauge or material that cannot be chewed or clawed apart.

To prevent passage of furbearers to floats, sheet metal collars should be erected on cables, boom sticks or stiff-legs which are attached to shore. Guard dogs and electric fences are also deterrents to the furbearers such as mink and otters.

3. Bears

A waste management permit (MEP) is currently required for disposal of all waste. Garbage should be kept to a minimum and incinerated daily. Waste Management Regulations relative to salmon farms are under revision at present.

Disposal of fish by-products and carcasses should be done in a manner to minimize the attraction of bears and to prevent the spread of fish disease.

4. Marine Animals

Heavy gauge nets should be used to prevent seals from gaining access to aquaculture operations. An enclosure within an enclosure may be the most effective way to prevent direct access by sea lions and other marine animals, such as dogfish. Routine removal of dead fish also helps alleviate dogfish predation.

MARINE PLANTS AND FOULING ORGANISMS

Good	Medium	Poor
Fouling organisms in low abundance. No nearby kelp beds or other macrophytes.	Seasonal increases in fouling organisms. Nearby kelp or macrophyte beds.	High year round abundance of fouling organisms. Kelp or macrophyte beds on site.

Fish Response:

No symptoms attributable to net fouling.	Short term seasonal fouling may cause symptoms of oxygen distress.	Severe stress due to chronic fouling, low oxygen levels.
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Effect on Operation:

Only require routine net maintenance.	Regular net maintenance. Increased cleaning required during seasonal fouling.	Frequent net cleaning and replacement required. Increase in net damage resulting in escapements.
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Interpretation

Most large marine plants (macrophytes) grow in less than 10 meters of water. Kelp species are among the largest marine plants on the B.C. coast. They anchor to rocky substrates, usually in areas of high current flow or wave action. Kelp beds constitute a nuisance to navigation, and can impede boat passage and entangle propellers. At certain times of the year, they may make a site inaccessible by boat. Kelp beds can also foul fish farm sites when fronds and other debris break off during storms. Some species of kelp undergo an annual die-off in winter, freeing large masses of drifting plant material that can inundate a site. In some areas, kelp beds act as natural breakwaters, altering wave action and attenuating currents. Sudden die-offs could have a profound affect on a site's current and wave regime.

The best time of the year to assess a site for potential kelp problems is between June and September, during the summer growth period. Kelp surveys conducted by the Marine Resources Section of the Ministry of Agriculture and Fisheries provide valuable information on the location and abundance of kelp at many areas on the coast.

Other macrophytes form habitats for a number of marine species. Eelgrass beds are among the most important because they provide refuge for outmigrating salmon, and offer a substrate for herring spawn. The proximity of a proposed site to an eelgrass bed may preclude its acceptance for fish farming because of the possible impact on natural wild stocks. The Department of Fisheries and Oceans of Environment Canada should be consulted in this regard.

Net fouling organisms consist primarily of algae, invertebrate larvae such as mussels and barnacles, and small plants (microphytes). The effects of fouling occur as soon as the nets are immersed in water. Microscopic plants and animals attach themselves to the nets and, as they grow, entangle larger particles of debris. The rate at which marine fouling builds up increases as water temperature increases (Kennedy, 1978) and as circulating currents decrease. In general, the longer the nets remain in the water, the greater the fouling load will be. Without routine cleaning, fouling will eventually build to the point of restricting water flow through the net pens. Fish have died at an experimental fish farm because of the lack of oxygen attributable to a heavy build up of marine fouling that restricted water circulation (Kennedy, 1978).

Another source of fouling may occur when net pens are located too close to natural herring spawning areas. Herring may deposit large numbers of eggs on the nets over a very short time. The result has serious consequences both in terms of restricted water circulation, and environmental impact. In some cases, operators may not be permitted, by law, to remove their net pens from the water until after the eggs have hatched. Without the opportunity to clean the nets an operation could lose an entire year class. Close proximity to herring spawning areas should be avoided.

Siting Opportunities

In general, sites with cool water and rapid current flow will have a slower rate of marine fouling than warm water, low flow sites. Water temperature has a direct effect on primary productivity, while current flows physically limit a fouling organism's ability to settle on nets or other objects. Fouling rates in Johnstone Strait waters would be lower than the Strait of Georgia for the above reasons.

Sites that experience high levels of freshwater runoff, such as Howe Sound, generally have less problems with fouling near the surface. However, these areas are usually unsuitable for fish farming because of the lower salinities encountered.

Mitigating Opportunities

Fouling of fish farming gear, or any other gear placed in seawater, is a

fact of life. Good maintenance practices carried out at regular intervals have no substitutes when dealing with fouling. Kennedy (1978) recommends that net pens should be changed at least every 3 weeks during the summer, every 3 months during the winter, and at intermediate intervals during intermediate temperatures (Kennedy, 1978). Regular inspection of net pens and their supporting structures is desirable. Mussel and barnacle accumulations must be avoided by changing the nets as soon as build up appears. Proper net pen spacing will slow marine fouling by ensuring adequate circulation throughout the site. The use of antifoulant chemicals to inhibit growth of marine organisms on nets should be approached with care, since many antifoulant chemicals are toxic, and may affect the fish and surrounding environment. Information on antifoulants and their impacts can be provided by the Ministry of Agriculture and Fisheries.

Debris from kelp beds and other flotsam encountered in the marine environment may be controlled by log or tire boom breakwaters. In areas that suffer high amounts of debris, nets suspended from these booms may also be required to protect the submerged portion of the net pen assemblies. These debris nets will require routine cleaning and clearing.

MISCELLANEOUS (SNOW, ICE, WIND AND WAVES)

Snowfall/Freeze

Good	Medium	Poor
<30 cm snowfall; no freezing of water surface	30-60 cm snowfall short duration freezes with ice <5 cm in thickness.	>60 cm snowfall; Ice >5 cm thick, lasting for days.

Interpretation

It is obvious that ice and snow can interfere with farm operation. Snow makes working conditions hazardous and inconvenient. Ice interferes with feeding of the fish, farm maintenance, such as cleaning nets, and can damage net pens.

Siting Opportunities

Northern areas of the coast are more prone to ice and snow conditions. Inlets with restricted entrance and large freshwater input may also be more prone to freezing because of reduced water movement or reduced surface salinities. The heads of some inlets, such as Salmon and Narrows Inlets, are also likely to freeze. Contact Environment Canada, Atmospheric and Environment Service for regional climatic information.

Mitigation Opportunities

Little opportunity exists to mitigate snow and ice problems if they are in the "poor" category. Thin ice can be broken, and moderate amounts of snow can be swept or shovelled.

Wind and Waves

Good	Medium	Poor
Site is not exposed to polar outflows; sheltered from the prevailing wind couplet of SE and NW winds; short fetch, with waves <60 cm.	Partial exposure to some polar outflow; exposed to either SE or NW winds; moderate fetch with waves 60-120 cm.	Complete exposure to the main thrust of a polar outflow; exposed to both prevailing SE and NW winds; long fetch with waves >120 cm.

NB Wave height criterion based on cage design.

Internal Waves

<u>Good</u>	<u>Medium</u>	<u>Poor</u>
None present.	Only artificially induced or very deep (no influence in upper 15-20 m).	Shallow, naturally induced.

Interpretation

Many locations would expose a farm to severe wind and waves if there is a long fetch and prevailing SE and NW winds. Such factors can negatively affect farm operation by causing rough water. Both high winds and rough water can cause physical damage to a farm in addition to making working conditions and water travel hazardous.

Also, wind can cause a standing wave phenomenon (Seiche), where surface water is blown to one end of an inlet or fjord. Where there are marked temperature (thermocline) and salinity (halocline) gradients, a farm may be subjected to sudden shifts in temperature and salinity. One end (usually the blind end of the channel/inlet) would receive a thick layer of surface water which may be very warm or cold, depending on the season, and may possess low salinity if there is a freshwater lens present. The other end of the channel would experience a surfacing of deep water which may be much colder than surface water in summer and much higher in salinity. An example of this is the south end of the Sechart Inlet. Reduced salinities at deep levels and rapid temperature changes can stress fish.

Rough water can also cause stress to fish if the wave surges penetrate deep into the net pens. There have even been reports of seasickness in fish, although no scientific documentation of such a phenomenon has been located at this writing.

Also, during times when water is very rough, the farmer may have to discontinue feeding the fish, possibly for several days.

Internal or gravity waves can also occur within the interior of a body of water, provided its density increases with depth (Thomson, 1981). They are generated by some influence such as tidal movement against sills or other bottom features which disturbs the equilibrium level between the upper, less dense layer and the deeper, denser layer. Gravity waves cannot exist in water of homogeneous density.

Unlike surface gravity waves, which possess maximum vertical water displacements of the surface, but decreasing vertical displacements with depth, internal gravity waves produce maximum vertical displacements

within the water column and negligible distortion of the water surface. In other words, the waves are only within the interior of the water body. Typical internal wave lengths in the Strait of Georgia are 25 to 100 m with wave heights of 5-10 m and propagation speeds of about 0.5 m/s (1 km).

Bute Inlet is an area known to possess internal waves throughout the water column, whereas Jervis Inlet possesses them at deep levels. Boundary Passage and Active Pass, as well as the Knight Inlet shallow sill, are vigorous sources for these waves which move slowly into the strait of Georgia or Knight Inlet (on the flood). In Johnstone Strait, strong internal tidal motions appear to be generated by swift tidal currents surging over the partial sill at Kelsey Bay, distorting tidal flow for about 10 km west of the sill. Knight Inlet wave crests are 70-100 m apart and possess an up-inlet speed of about 50 cm/s (1 km) (Thomson, 1981).

The main impact of such waves can be a series of horizontal current reversals, causing rapid sequential changes in temperature and salinity values in stratified waters over short periods of time. This can place even more stress on fish than waves caused by seiches, because of the frequency of the oscillations, and because they tend to be a regular occurrence when tidally induced. Other sources for such waves exist, such as atmospheric pressure fluctuations, ship propellers, the mutual interaction of waves in a sea, or a swell. These sources, however, tend to be less regular or frequent.

Siting Opportunities

Exposed areas with long fetches should generally be avoided, especially where the prevailing couplet of NW and SE winds can affect a farm. Also, areas subject to polar outflows, such as Howe Sound, and Knight, Bute and Toba Inlets should be generally avoided. These are areas where long channels and valleys penetrate into the province interior and receive cold polar outflows which can howl down channels with gale force winds for several days at a time (Thomson, 1981).

There may be isolated sheltered spots in some of these locations. However, there may be problems with transportation to and from sites due to rough water in the vicinity. Environment Canada, Atmospheric and Environment Service can provide some information on prevailing winds.

Areas subject to internal waves such as locations close to sills should be avoided.

Mitigation Opportunities

The wave criteria stated above are based on a standard cage design net

pen for an average farm (15 X 15 X 12 metres). From a farm and fish safety perspective, one can, of course, design for winds and waves which would receive a poor rating; it is simply a matter of deciding how much capital one is willing to invest in a farm.

Cages can be built deeper to allow the fish to escape the surface wave surges. Booms and pens of heavier construction can be placed on site. Stiff legs, if feasible, can also add to the security of a site.

At certain times of the year, however, a farmer located in a poorly rated, isolated site will have to be resigned to being stranded for days at a time.

There are no known mitigation methods for internal waves.

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MARCH 20, 1988



ALMON

are industry

Editor's Notes

By GEORGE BRYSON

We come to our cover story on the burgeoning salmon-farming industry this week (burgeoning, that is, just about everywhere but Alaska) with a few biases.

We admit at the start our particular love for salmon. We love to fish for them. And after we have caught them, we love to eat them. Beyond that, there's a special respect here for the thousands of Alaskans who make their living as commercial salmon fishermen.

The point is, we openly admire these people who make their living in the honest, time-honored method of "Those that go down to the sea in ships." Fortunately, commercial fishing is flourishing in Alaska now as never before.

Which brings us around, in a manner, to fish-farming, or mariculture — which is just starting to flourish as well, though only in other places. The harvesting of Pacific salmon in pen farms in Alaska's tidal waters is opposed by leaders of the United Fishermen of Alaska. The group representing 12,000 Alaska fishermen is concerned about the competitive aspects posed by fish-farming, as well as its environmental risks. Its leaders say that farm-raised salmon could spread disease to wild salmon stocks.

Supporters of mariculture, on the other hand, say fish-farming poses no greater risk of disease to wild salmon than do salmon hatchery operations, which have enhanced natural fish stocks in Alaska for years.

While the debate isn't likely to subside any time soon, our magazine doesn't plan to join it this week. Instead, this issue focuses on the nature of fish farming, both here and abroad. We do so hoping that when the debate rises in Juneau once more, we might know something of what they're talking about. ♀

This Week

FUTURE STOCK? A federal research center on Baranof Island is studying salmon farming — otherwise forbidden in Alaska. The technology is promising, but commercial fishermen's fears are likely to put aquaculture on hold in Alaska. By Hal Bernton. Page 6.

COVER: Photo of king salmon fry by Michael Penn.



Roy Martin, project supervisor at the Osprey Bay fish farm in Southeastern Alaska, opens a shed that holds fish feed.

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We Alaskans

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General Delivery

March weather teases the jogger dreaming of spring

By BARBARA TAYLOR
 Wasilla — Winter 1988

Fickle March weather. Now the guessing game begins. Jogging along at 20 degrees, I'll be just right in my sweats and a cotton blouse. Mitts, a sweatband around my ears and sport socks in my running shoes will do.

But is a breeze gusting down the road? Chilling wind cuts through my sweatshirt and pants. Maybe add my windbreaker and long johns under my sweat pants, a wool hat to shield my forehead.

The general rule: Dress for 10 degrees warmer than the actual temperature. If it's 15 degrees, act like it's 25, because body heat from exercise will keep you comfortable — not too hot, not too cool.

Tomorrow's forecast says minus 5 degrees. Put on wool socks, a cotton turtle-neck under a wool ski sweater and pull the hat down low.

Outside, it is crunchy cold as I begin a slow jog down our long driveway. My cheeks, chin and nose quickly begin to sting. Drawing off my mitt to rub my face

with one hand, I know I'll soon be warmer as my body puts out more heat.

What a good run. My body flows easily with the rhythm of my legs. Breathing is steady and slow. As the miles slip by I can feel the cleansing sweat and heat evaporate through my clothes; my tensions and frustrations evaporate as well.

Now I pause to watch. The pale Chugach Range parades pinks and purples like a pastel display of the aurora borealis. But chill quickly seeps through my damp clothing. Time to go back.

Halfway home, the sound of a snapping stick brings me to a halt. A huge paddle-eared moose blends softly into the trees, her brown coat muted by the early morning shadows of the spruce and birch, her long legs mimicking the slender trunks. "Hi there, girl," I speak softly. We stare at each other, and I walk slowly by, not wanting to disturb.

How is it that one day the cold drills into my fingers like sharp immunization needles, and the next day — a warm thaw?

A chinook? Shed the hat, long johns and

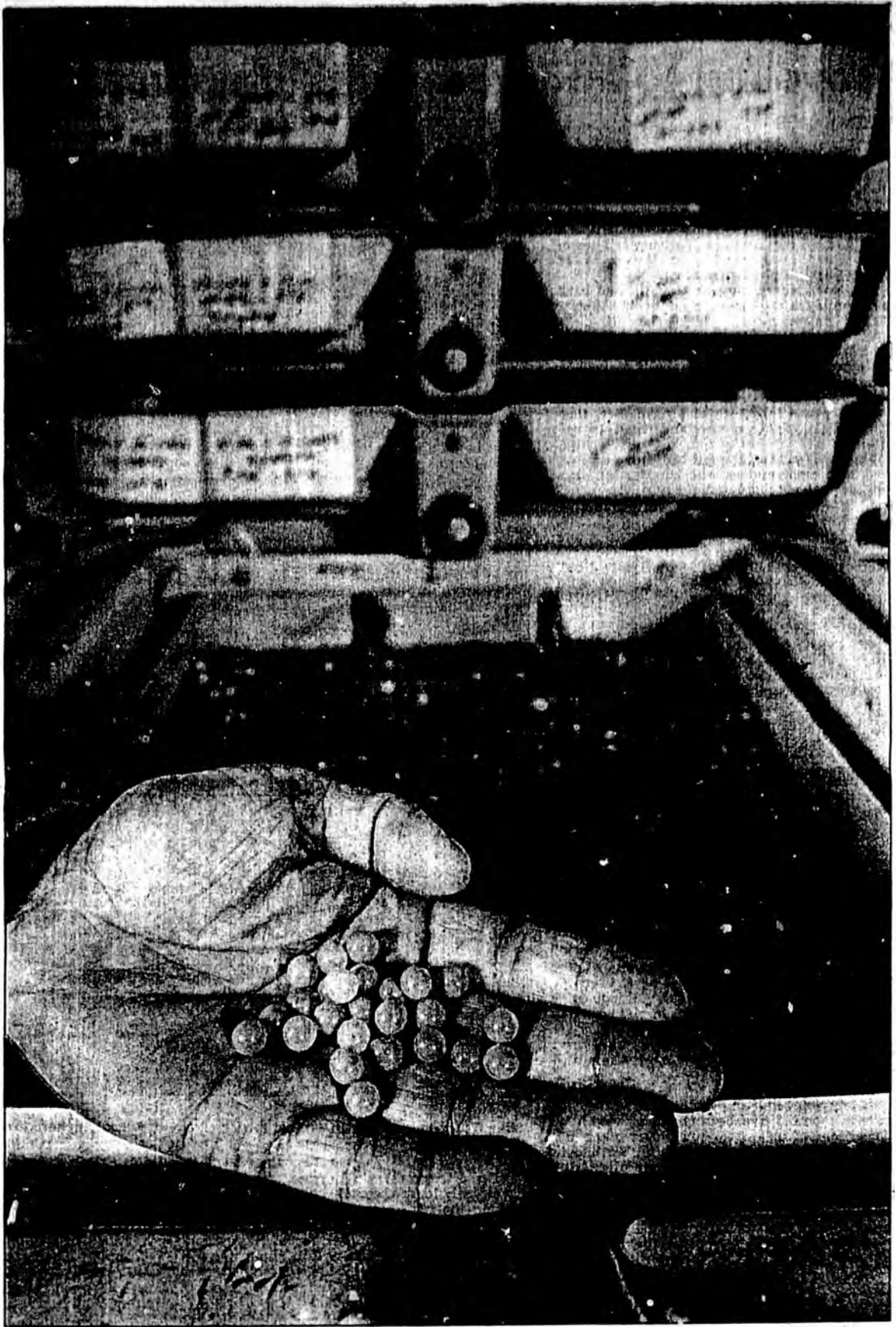
wool socks, even the sweatband. Back to sweats for 40 degrees. I feel light as a sheared lamb. This time I tread along with balmy breezes ruffling my hair. As the miles slip by, all of me responds to the measured beat of my body harmonizing with the measured cadence of the Earth. I fit. My senses are tuned to the mood of nature and I am confident.

Oh, shoot. Rain. No slicker for me. I slog through the slush, droplets coursing down my hair, spurling in a miniature waterfall off my nose, leaking into my eyes and ears. Soggy sweats cling to my skin like stubborn Saran Wrap as I quicken my pace.

Wet birch bark turns a rich brown, reminding me of spring. On I slosh. Ah yes, spring. Budding green leaves...

When I slip in the slush I'm jerked back to March, but those tantalizing memories of sweet scented air, little flowers and warm, long days haunt my thoughts.

Fun? Well, yes, if you're part chameleon and can change clothes just as fast. Bless the season of shorts, a top, shoes and socks for three whole months. ♀



King salmon eggs in front of their incubator at the Little Port Walter research station on Baranof Island.

FUTURE STOCK

Researchers know how to run efficient salmon farms, but commercial fishermen's fears may sink mariculture

By HAL BERNTON
Photos by MICHAEL PENN

On the southern edge of southeastern Alaska's Baranof Island, a federal research station is experimenting with a technology now forbidden in the rest of Alaska — the farming of salmon.

National Marine Fisheries Service biologists at Little Port Walters hatch king salmon eggs in incubators and nurture the smolt in the fresh water of an estuary. Then they raise them to sizes of up to 25 pounds in salt-water pens a few miles away at Osprey Bay.

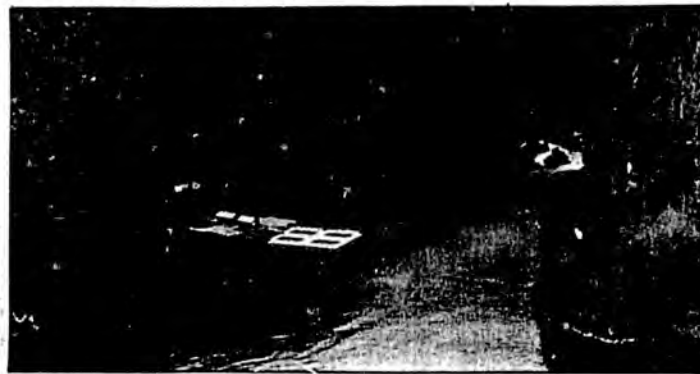
The project is supported by the state Commerce and Fish and Game departments. In Norway, Canada, Chile, Japan and a dozen other

nations, this technology has created a major industry that now produces more than 280 million pounds of

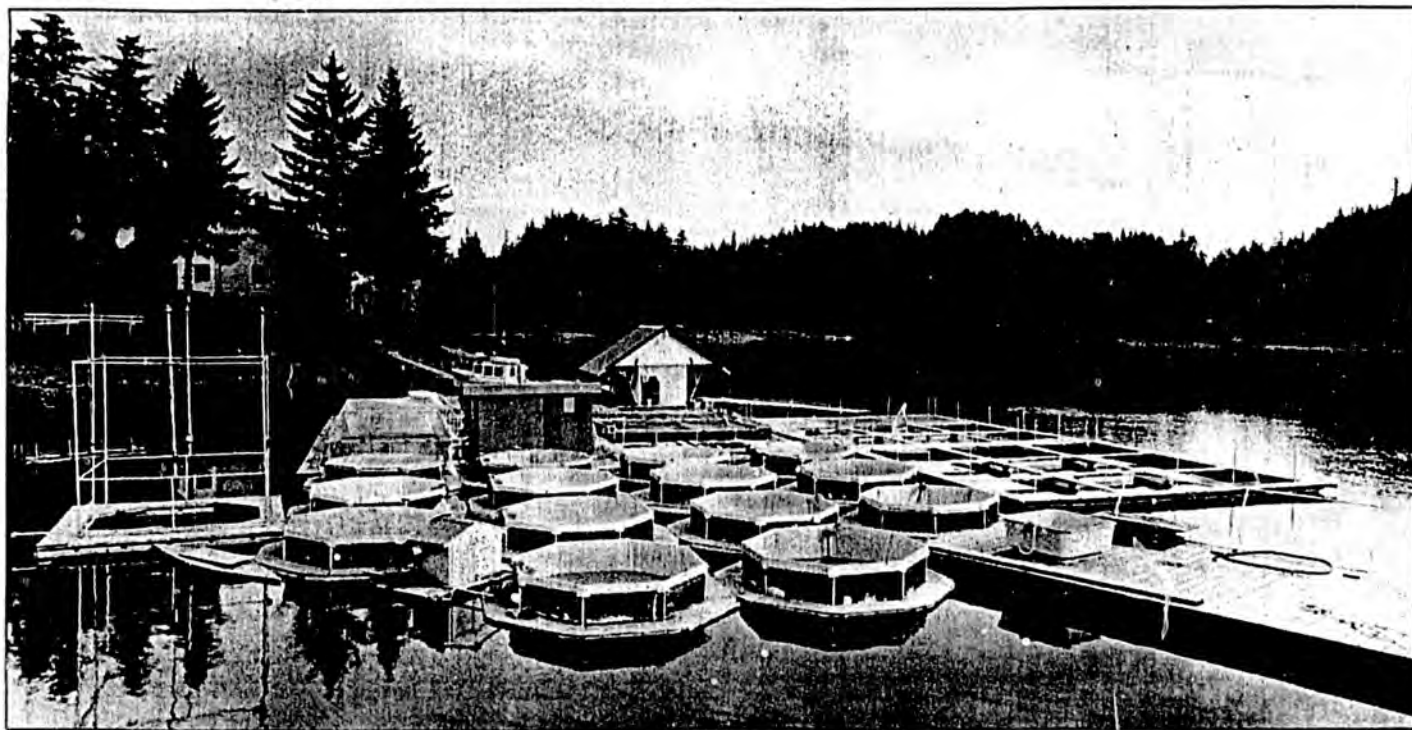
fresh salmon each year for international seafood markets. Some entrepreneurs would like

to lease state tidal waters to establish the industry in Alaska, but many fishermen vigorously oppose the idea. They fear both the competition that farm-reared salmon might pose to sales of wild salmon, and possible harmful environmental effects of salmon farming.

In Juneau, 150 miles north of Little Port Walters, the legislature is determining the industry's fate in Alaska amid an intense lobbying campaign by both advocates and opponents. More than a half-dozen bills addressing the future of salmon farming have been submitted to House and Senate committees. They range from an outright ban on the industry to a gradual leasing of state tidal waters to a new generation of Alaska fish farmers.



An aerial view of the Osprey Bay fish farm.



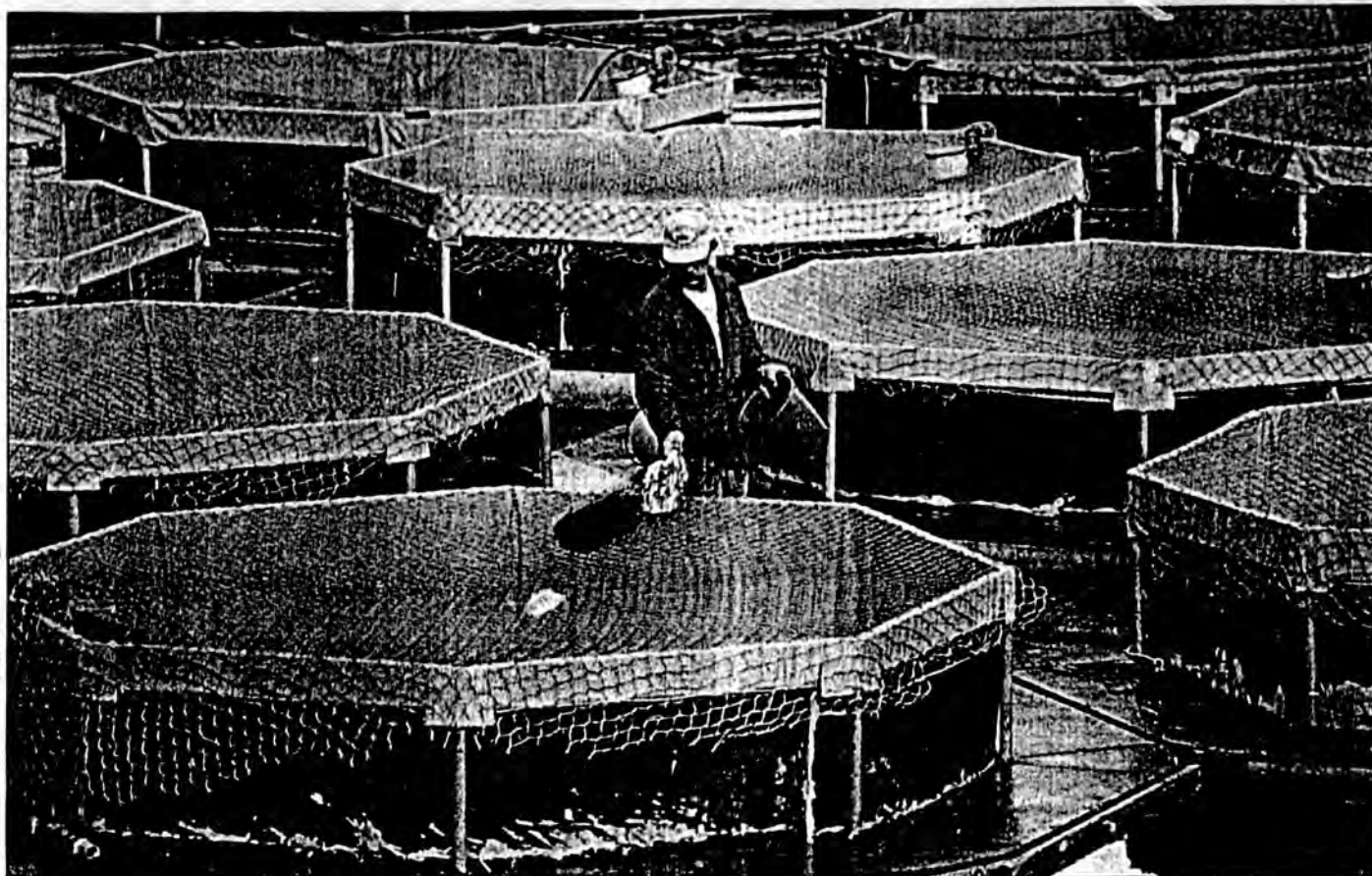
Fresh- and salt-water pens for salmon surround the Little Port Walter fish hatchery.



Jeff Hard dumps just-tagged fish into hatchery pens.



Bill Heard, project manager, holds a 3-year-old king salmon that has spent its entire life at the Baranof Island fish farm.



Fish and Game fish technician Roger Vaillon feeds penned salmon at Little Port Walter.

How a fish farm operates

The federal fish farm at Little Port Walters is an extension of a research hatchery that for decades has raised young pink, silver and king salmon for release into the wild, where they supplement both commercial and sport fisheries. The practice is known as aquaculture, and has widespread support from Alaska fishermen. Such hatcheries — some owned by nonprofit organizations supported by fishermen, others by the state Department of Fish and Game — release close to a billion fish into the ocean each year.

The farming process at Little Port Walters begins with collection of eggs from the more than 5,000 king salmon that now return each August to spawn at the hatchery. The salmon are captured as they swim up a fish ladder and placed in fresh-water holding ponds until eggs and sperm are ripe.

The fish produce more than 6 million eggs, most of which are given to other state and private hatcheries. Fertilization of the eggs is achieved by mixing them with sperm milked from male kings. About 300,000 eggs are incubated at Little Port Walters until they hatch in December or the following May, depending on the system of incubation used.

For scientists seeking to propagate the species, female kings are more desirable than males. A small amount of sperm can fertilize a vast number of eggs. They have discovered that a mix of ultraviolet radiation and warm-water

baths can change the genetic material of the sperm and eggs to almost eliminate male offspring.

Addressing fishermen's fears

Once the fish hatch, they are placed in 13-by-12-foot, corral-like plastic raceways that float in a fresh-water estuary. The oxygen the fish need to survive is provided by a constant flow of fresh water through the pens.

Normally, the young salmon are kept in raceways for about a year, until they are ready to make the transition to a salt-water environment. But scientists have learned to speed up that process by gradually mixing salt water into the raceways.

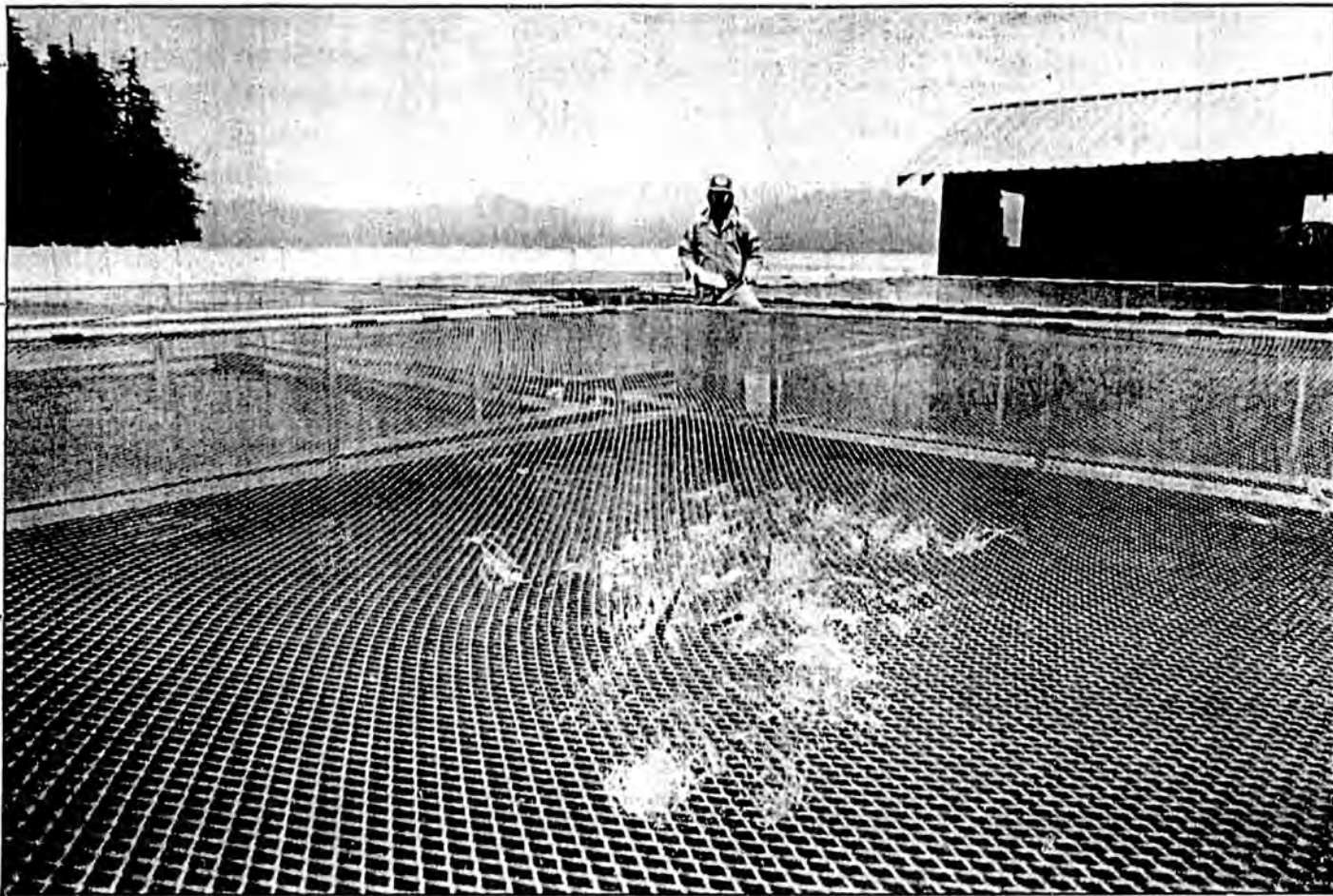
Fishermen are worried that the fish-farmed salmon — crowded in their raceways — will be susceptible to diseases that might then ravage wild salmon stocks. Salmon in the fresh-water phase at Little Port Walters have been struck by a bacterial infection that attacks fish kidneys, and in the salt-water phase by another bacterial infection known as vibrio.

But these diseases also are common in wild stocks, as well as in fish raised by fishermen's aquaculture cooperatives, according to Frank Thrower, a research biologist.

Both diseases can be easily treated with antibiotics, Thrower said.



Blood samples are taken from the fish to determine sodium levels.



Frank Thrower watches as 1-year-old salmon break into a feeding frenzy.

Location crucial

Most of the 300,000 king salmon raised annually at Little Port Walters follow the traditional Alaska hatchery cycle. They are released into the sea. Some will end up in the holds of commercial fishing boats; some may be caught by sports fishermen; a few will return two to four years later to spawn at the hatchery, where their eggs and sperm will be harvested to propagate the new generations.

The fish farm experiment involves a few thousand of the smolt. These fish will never know the freedom of the open sea. They're confined to salt-water pens, where they're fattened on feed until ready for harvest.

If Little Port Walters were a commercial salmon farm, several hundred thousand of these fish might be raised in the pens to sizes ranging from 1/4 pound to more than 6 pounds.

The fish-farming experiment began in 1984, when scientists transferred the first 2,000 young kings from the fresh-water raceways to salt-water rearing pens at Osprey Bay. The pens are made of plastic pipe and nylon mesh formed into 40-foot-long squares, and hold between 3,000 and 5,000 fish each.

The salmon dine on protein-rich pellets made from the herring and salmon wastes of seafood processing plants. The salmon is remarkably efficient at converting waste protein into edible meat; each 1.5 to 2 pounds of feed yields about 1 pound of salmon flesh, a much more efficient conversion rate than achieved by either chicken or cattle farmers.

What little waste is produced by the Osprey Bay salmon doesn't foul the surrounding water.



Concentrated fish food.

Three times a year, the pens are cleaned of barnacles and algae. Little fish waste or unused feed has been found to pile up on the bottom underneath the pens.

Thrower says the lack of pollution is due to a steep-sloping bay floor and strong currents that help flush wastes out to sea. "If you fish-farmed in an area that was relatively shallow, then you would accumulate feces and food on the bottom," he says.

Currents and ocean topography are just two of many factors that need to be considered when choosing a site for a salmon farm, according to biologists. To prevent mixing of farm-reared salmon with wild stocks, the farms also must be kept at least 30 miles away from bays that support wild runs.

"I personally think that if you apply this conservative approach, there's a great limitation on the numbers and kinds of locations where (Alaska) salmon farms can occur," says Bill Heard, a biologist at Little Port Walters.

In British Columbia, the salmon farming industry boomed in the mid-1980s with little

regulation. Bitter conflicts arose among salmon farmers, recreational boaters and other coastal-water users, prompting the provincial government to re-examine its permit policies.

In Alaska, legislative bills to legalize salmon farming call for the state to develop extensive regulations over the location of fish farms.

Industry's future uncertain

The salmon farm now has about 8,000 fish at different stages of development confined in salt-water pens.

After eight months on a high-protein diet, the salt-water kings have grown to weights of up to 2 pounds, a pan-size fish suitable for sale to some supermarkets. After 2 1/4 years on the diet, the fish weigh up to 9 pounds, large enough to compete with Norwegian-farmed salmon for the gourmet restaurant trade.

After three years in the pens, some fish have reached sexual maturity, Thrower says.

These growth rates compare favorably with those of the Atlantic salmon, the favored fish of Norwegian fish farmers.

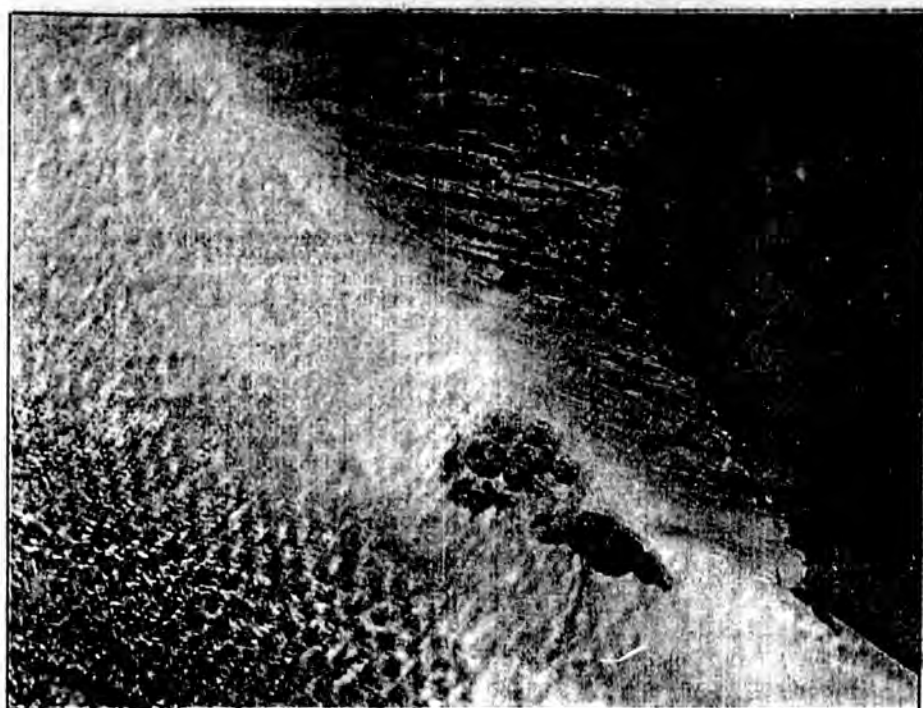
Biologists at Little Port Walters now think no major technical obstacles stand in the way of Alaska salmon farming.

And would-be salmon farm entrepreneurs think they could use this technology to create a major new industry for coastal communities. Fish feed, for example, could be created from the wastes now jettisoned by many processing plants.

"Considering our state's economic situation, we need to take advantage of mariculture," says Paul Fuhs, mayor of Unalaska.

But the Alaska future of salmon technology remains much in doubt.

"Ninety percent of the wild salmon in the



A captive salmon fin with fish lice attached.

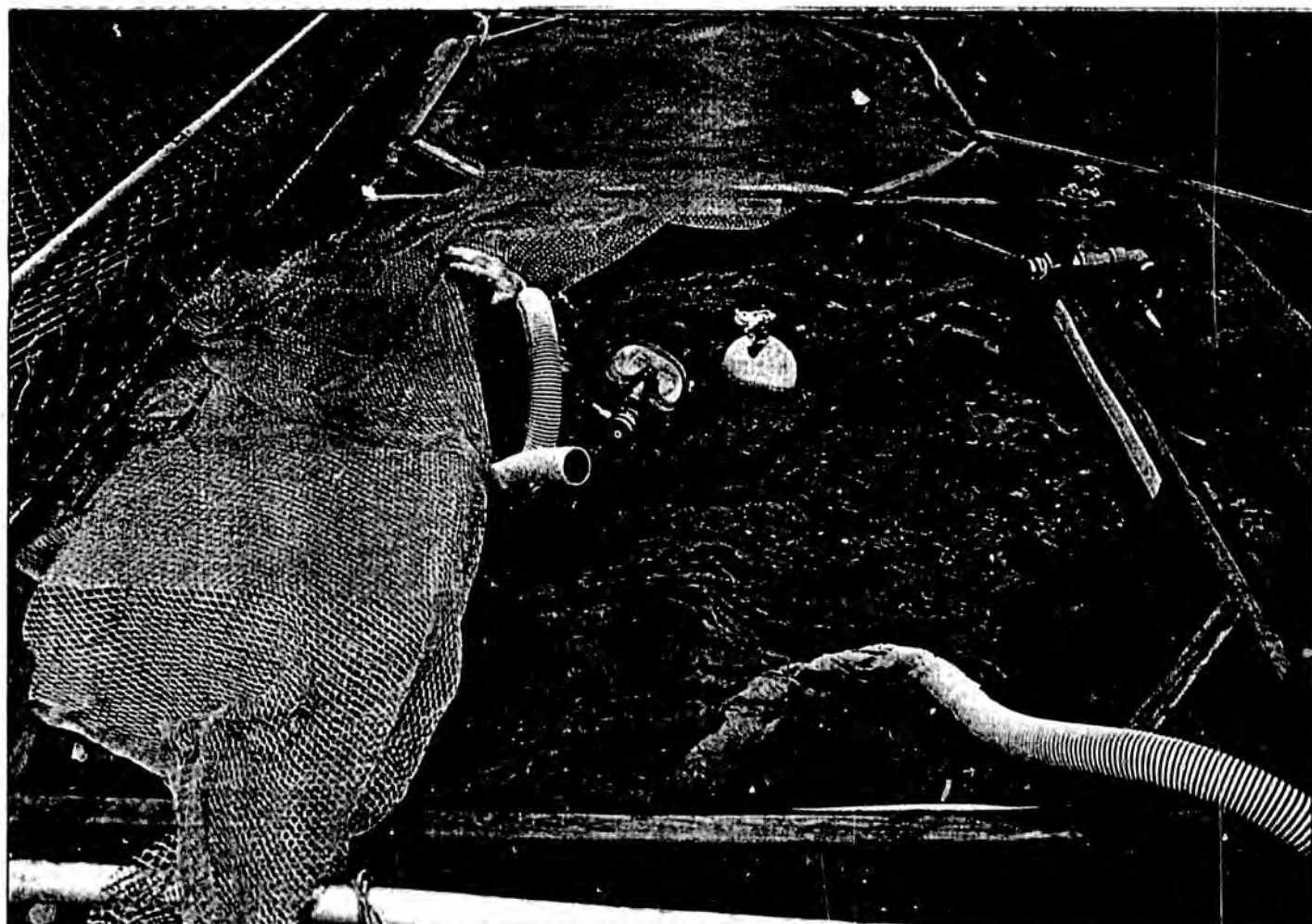
“Ninety percent of the wild salmon in the U.S. and 43 percent of the wild salmon in the world swim in Alaska waters. We believe Alaska has a prime responsibility to protect that wild resource . . .”

— Cheryl Sutton of the Kenai Peninsula Fishermen's Cooperative Association

U.S. and 43 percent of the wild salmon in the world swim in Alaska waters. We believe Alaska has a prime responsibility to protect that wild resource for both economic and environmental resources,” says Cheryl Sutton, executive director of the Kenai Peninsula Fishermen's Cooperative Association, a group lobbying to ban salmon farming in Alaska.

If the fishermen win their battle, sea-farming technology in Alaska will remain the part-time preoccupation of a handful of research scientists. **A**

□ Hal Bernton is a Daily News business writer. Michael Penn is a Daily News staff photographer.



Project supervisor Roy Martin surfaces in a salmon pen with the vacuuming equipment used to clean the nets.

THE FISH-FARM BOOM

Aquaculture raises huge profits — and troubling questions

By NATALIE FOBES

Salmon culture is a phrase buzzing through the seafood industry, terrifying fishermen, titillating restaurateurs and seducing investors.

Raising salmon specifically for harvest may change the way we think about those incredible creatures. The potential is there to produce low-cost, high-protein food. The smart money says that potential will be realized.

It was only a matter of time before the salmon's instinct to return to its natal rivers was exploited. People asked: Why not ranch them? Rear them in a hatchery to smolt size, send them out to graze in the ocean, and when the adult fish come back in three to four years, harvest them. It makes more sense than chasing salmon all over the ocean as commercial fishermen do now.

Or maybe we can farm them, they continued. Raise salmon in net pens in salt-water bays as well as fresh-water rivers and lakes until a restaurant or broker puts in an order. Harvest the fish and deliver them to the customer. Salmon on demand — fresh, the right size and only hours out of the water. Salmon farming is a big industry in Norway, Great Britain and even Tasmania, and has been for years. No reason it can't be done with Pacific salmon.

Simple concepts, yes. Controversial, absolutely. The idea of ranching and farming salmon has exploded in debate.

Environmentalists claim that fish feces and feed debris from salmon farms will pollute the water and accumulate on the ocean's bottom.

Property owners with spectacular views don't want net pens in the way.

Commercial fishermen say large-scale ranching might very well put them out of business.

Sociologists question whether the public domain should be used for private profit.

Biologists worry about disease contamination between farmed or ranched salmon and native stocks, and how the infusion of millions of ranched fish will affect the food supply in the ocean and rivers.

Some go so far as to suggest interbreeding could mean the end of wild native salmon, currently found in decreasing numbers in the Northwest. Others say salmon culture will be the salvation of the stocks because it will decrease the commercial salmon harvest.

Everyone has an opinion. But all agree salmon culture is here to stay.

"It's not a matter of whether it will go," said Connie Mahnken, aquaculture specialist with the National Marine Fisheries Service. "It's a matter of who's going to do it."

And companies in the United States, Canada, Chile, Japan and New Zealand are all trying their hand at it.

□
New Zealand is a nearly perfect location for salmon culture. The water is cool and clean. The introduced quinnats (chinook salmon) have been adapted to pen-rearing and ranching. Labor costs are low. Few people complain about the sight of net pens or ranches because few people live near them. The seasons are opposite those in the Northern Hemisphere, so the product doesn't compete with Alaska and Pacific Northwest salmon in the marketplace. And there is no commercial salmon fishery.

The industry has boomed since the first ranch was formed in 1977. Two years later, 100 fish returned to the ranch. In 1986, more than 23,000 fish were harvested at four recapture



Anchorage Daily News file photo

Commercial fishermen are among those who fear that salmon farming is not the breakthrough its proponents claim.

sites in New Zealand, accounting for approximately one-fifth the world total of ranched Pacific salmon.

Today, six different companies raise salmon in pens in Big Glory Bay. When commercial fishermen in the Northern Hemisphere hang up their lines and nets in November, the harvest begins at the salt-water pens in New Zealand. The farmers ship fresh fish to ports like Seattle and Tokyo until March. Most of the 800 metric tons harvested annually ends up on the plates of restaurants at least 17 hours' flying time from New Zealand — a world away to those who harvest the salmon.

At 5 a.m., employees have already assembled on the wharf in Oban. Outlines of the New Zealand Salmon Co. net pens are barely visible as the boat nears the farm. Four separate farms with 28 or 30 pens each are anchored to the bay's bottom by a series of 2-ton concrete blocks.

This morning, the water is undisturbed, save for the wakes of yellow-eyed penguins and the boat. The vessel pulls aside the first of two pens to be harvest.

Salmon are herded from the 8-meter net into a smaller net pen. A blue plastic tarp has been placed under the pen, preventing the circulation of fresh water. Carbon dioxide is pumped into the water to stun the fish.

Within seconds, the glasslike pane of water breaks. Silver scales scatter light. Splashing obliterates the sound of the portable radio. Gills working, mouths gasping, the salmon leap and dive.

For five minutes the splashing continues unabated. Then the activity in the water slows. Salmon float belly up, their tails occasionally powering a last futile attempt to escape. Tom Learmouth, the company's harvest manager, nods. "Let's go," he says.

The beauty of salmon farming is its harvest efficiency. Two-and-a-half tons of fish are taken from the pen in less than two hours. Three hours after the salmon have been killed, they are on a plane bound for the United States. Thirty-six hours later, the filets are a dinner entree.

Despite the jet-age efficiency problems may eventually sabotage the industry.

Many observers suggest that New Zealanders too readily accept risky ventures. "The 'kiwi into the wind' trait runs deep here," said Lawrence. "Unregulated development, a carte-blanche approach, could have a negative effect. We just don't know." The number of salmon the waters of the continental shelf can feed is unknown, he added.

□
It's 5 a.m. at the fish market in Tsukiji, Japan.

Horns blare. Engines roar. Styrofoam squeaks. Voices shout. Look alive, step quickly, or run the risk of becoming a spot on the spotless floor.

Stacked on tables and floors are bluefin tuna the size of Honda Civics, crates of live crab in sawdust, fish in boxes, fish in crates, fish in aquariums and salt water tanks and freshwater buckets.

An auction begins. Laughter and talk ebb as rows of men, numbers in hats, clipboards in hand, turn their attention to the auctioneer. He blasts out the prices and lot numbers, commanding the men to bid. Fingers pierce the air as brokers reply. No stopping, no slowing; the group moves from row to row of salmon or tuna or roe or squid until the section is gone. Then the buyers disappear.

Here a person begins to get a sense of the importance of seafood to the Japanese. The Japanese have the highest consumption of fish in the world: 75 pounds per person per year. They raise shellfish and seaweeds, octopus, eels, sea urchin and salmon, and are known as the foremost aquaculturists in the world.

But it isn't until you see the acres of sample fish spread out in one spot that you begin to understand why the Japanese own 80 percent of the salmon-processing plants in North America. Why they are involved in aquaculture in Chile, Canada and New Zealand. Or why some individuals risk going to jail and paying a fine for illegally importing Asian salmon laundered through the United States.

From the sashimi bars at Tsukiji to Aihara's Restaurant in Ishikara, salmon is an honored guest. Twenty years ago, that salmon might not have been a guest at all. But Japan's production of chum salmon has increased tenfold since 1965.

In 1955, the government began a series of five-year plans designed to increase domestic salmon production and reduce dependency on offshore fishing. When the United States and Soviet Union extended their coastal zones in the 1970s, limiting that fishing even more, the Japanese were ready.

"We anticipated the expansion of the zones," said Takeshi Yamamoto, a government fisheries official. "So we expanded our production." The country's domestic chum stocks now repre-

A look at salmon farming around the world

Where did that alder-smoked salmon filet with a hint of rosemary come from? Was it pulled from the sea by exhausted fishermen in the middle of the night, in the middle of a storm? Or was it taken from a net pen and rushed to the restaurant in which you are dining? There's a one-in-10 chance that the fish was from the latter. Three years from now, those odds will likely triple.

United States

Three problems face salmon culturists in the Lower 48: The resistance of waterfront property owners to farms and ranches that impede their views; water quality and bottom debris from farms; and the political clout of commercial fishermen.

California has one experimental ranch, Oregon has 12 ranches but no farms, Washington has no ranches but three companies with seven farms, and Alaska has 15 private, non-profit hatcheries that for all intents are ranches, and a federal research station in Southeast Alaska where National Marine Fisheries Service biologists are experimenting with a small-scale fish farm (see the story on Page 6).

Canada

Salmon farming has exploded in the last two years on the largely uninhabited Sunshine Coast of British Columbia. When asked how many net pens were operating in the province, Bud Graham of the Department of Fisheries and Oceans replied, "Which day of the week do you want? The number is growing exponentially." As of March 19, 1987, a hundred farms were operating with 466 applications in the permit process. A year before, there were only 30.

Japan

Japan is the largest producer of farmed Pacific salmon. The country supplies 2,500 metric tons of the world total of 10,000 metric tons, the vast majority from Shizu-gawa.

Pollution from the last decade of farming may throw a wrench in the works. Tests indicate sediment buildup of 15 to 30 centimeters on the bottom of the 14- to 22-meter-deep bay. The fishermen are trying to find an answer to the problem. They are considering solutions as simple as "crop" rotation to one as complex as coating the bottom with a charcoal-based material.

Norway

The giant of salmon culture, Norway

raises only Atlantic salmon. The country's production of salmon has been estimated at 43,000 metric tons per year. Three years from now it will be well over 90,000 metric tons. For perspective, the world's natural production of wild coho and chinook is between 45,000 and 60,000 metric tons per year. Norway's companies are investing in Canada, the United States, Chile and Tasmania.

Chile

A half-dozen companies from four different countries are producing coho, chum, chinook and Atlantic salmon. Jon Linbergh, a salmon culture consultant, is convinced Chile will be second only to Norway in tonnage of farmed and ranches fish in a decade.

Like salmon culture everywhere, the endeavors have not been without trials and tribulations. Only five chum out of thousands released returned in one experiment with ranching. To add insult to injury, the salmon returned 500 miles south of where they were supposed to.

□ From "The Promise of the Future" by Natalie Fobes, published in "The Reporter," a publication of the Alicia Patterson Foundation.

sent 38 percent of the world's production of Pacific salmon.

Forty-nine million chum salmon return each year to Japan's northern coast, an area about one-third the size of California. More than 168,000 metric tons of fish are harvested. All of the 2 billion smolts released annually are raised in hatcheries.

The statistics are staggering. The United States, in comparison, released approximately 805 million smolts in 1986.

"Salmon culture has developed like a flower taking a hundred years to blossom," said one government official.

The technology is certainly not new: the Chinese propagated fish as early as 2,000 B.C., and probably passed their knowledge to the Japanese. In 1716, samurai Buheiji Aoto divided a river into several channels to increase its spawning area, and in 1888 the first hatchery was built on the northern island of Hokkaido. Salmon are now produced in 16 northern prefectures, or states, and on the island of Hokkaido by 313 private, prefectural and federal hatcheries.

"We are changing our target from increasing the amount to improving quality," said Takeshi Yamamoto of the Japanese Fisheries Agency.

There are two ways to create higher-grade fish, he said. One is to emphasize hatchery programs featuring different species such as sockeye, coho or cherry salmon. The other is increasing the oil content of the flesh, making it more succulent. The government is attempting to reach that goal through egg transfers from one river to another and through genetic manipulation.

Many are concerned that the gene pool's diversity is shrinking due to these egg transfers and the years of interbreeding. Negative characteristics that tend to be weeded out by nature may surface because of these practices, experts warn. These traits include a sensitivity to disease or a tendency toward smaller fish.

To prevent this problem, Hokkaido's fisheries agency wants to set aside four island rivers that would act as gene banks. Stock in these streams would not be mixed with salmon from

other waterways, thus keeping its gene pool unadulterated.

Officials admit that the installation of the "gene bank" plan is many years away. First streams must be found where the stock is relatively pure. After a hundred years of aquaculture, that may be easier said than done. And once those streams have been chosen, the commercial fishermen must agree to the plan. The architects of the plan anticipate a three- to four-year fight as the co-ops and government negotiate the necessary restrictions. Salmon culture is at best a precarious compromise.

□

The future of Pacific salmon lies in the hands of many cultures — the Ainu and Yakima Indians, the Russians, the Americans, the Japanese and Canadians, the New Zealanders and the Chileans. But no matter what policies these people adopt, one thing is certain, say most observers: The future will include salmon culture. It must, in order to provide enough fish for commercial and sport fishing.

All countries supplement their wild salmon runs with hatchery-produced fish. Even the Chinese are enhancing their stocks. The question that must be answered is how these releases and the private salmon-ranch releases affect the well-being of wild stocks.

Few question the hypothesis that accidental interbreeding between native and farmed or ranches stock will weaken if not devastate the genetically unique wild salmon. What is not known is the impact that large numbers of hatchery-produced salmon may have on the amount of feed in the ocean, rivers and streams.

Scientists believe the ocean and watersheds have a finite amount of food. While the number of salmon now produced doesn't begin to come close to historic levels, some ocean and river feeding areas may be "overgrazed." In the food fight between wild salmon and artificially propagated fish, the latter will win, experts say. Hatchery-produced fish, raised in high density situations, spend their entire lives competing for food.

Biological concerns are not the only salmon-culture questions with which to wrestle. Who

owns the privately ranches fish when they are at sea? Once in the ocean the fish become a public commodity, according to legal precedent. While salmon ranchers accept the concept, they claim that commercial fishermen prey upon the returning ranches salmon. This is unfair, say the ranchers, because the fishermen know when and where the fish are returning.

The fishermen respond that the salmon ranchers are making private profit from a public resource and ask if this is just.

Critics ask commercial fishermen if they, too, are not making a private profit from a public resource. Half of the salmon produced in Washington state are hatchery fish. General fund tax money supports these hatcheries. Therefore, the public subsidizes the fishermen.

Certainly these questions must be addressed before salmon culture can come into its own. But the day may come when all the salmon we eat is raised in pens or harvested by ranchers. The thought is disturbing to many.

Pacific salmon mean much more to the people of the Pacific Northwest than a great-tasting source of protein with low cholesterol. Salmon represent the underdog, always struggling and sometimes winning against great odds. They are a reminder that nature has a plan for all creatures, that the environment is indeed a series of interlocking spheres. The salmon symbolize an innocence lost when the vast forests were cut and the raging rivers dammed, and when the views of the mountains were replaced by city skylines. And maybe a bit more of that innocence will be destroyed when salmon are raised like chickens.

"The lack of pure nature destroys the human mind," said anthropologist Masakazu Yoshizaki. And pure nature is the essence of the Pacific salmon. ■

□ Excerpted from "The Promise of the Future" by Natalie Fobes, reprinted from "The Reporter," a publication of the Alicia Patterson Foundation. Natalie Fobes, a photographer on leave from The Seattle Times, received an Alicia Patterson Fellowship and chronicled the struggle of the Pacific salmon to survive.



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Shellfish Mariculture

by

Michael Kaill

Mariculture Coordinator

FRED Division

Alaska Department of Fish and Game

Introduction

Alaska has the potential to enter a new resource industry — shellfish mariculture. Although oyster farming has been with us for some time, its growth has been hampered by lack of infrastructure. Culture of other species of shellfish, though unproved in Alaska, has been demonstrated in Japan, Canada, and the Pacific Northwest as well as other places. Recent action by the Alaska legislature has begun to clear away some of the obstacles keeping Alaska from realizing its potential.

Environmentally, Alaska is well suited to shellfish mariculture. However, there are some challenges that must be addressed.

Bourne and Brett (1984) suggest that:

"Several criteria must be considered when deciding if an animal is suitable for culture; three of the most important are an inexpensive and plentiful source of juvenile (seed), a rapid growth rate (or reasonably so), and a high price for the product."

Added to this are the technical as well as social factors involved in site selection for a sea farm in Alaska's tidewaters.

Permitting and Permit Activity

Legislation has been passed to authorize the collection of spat for bivalve shellfish farming. In order to meet the intent of this legislation, the Alaska Department of Fish and Game (ADF&G) has undertaken the following tasks:

1. Created a permit system for commercial collection of spat (juvenile shellfish) to be used as seed for bivalve shellfish farming. At this time there are three commercial scallop spat fishermen.
2. Revised the Fish Transport Permit (FTP) so that it will be appropriate for the shellfish program. The purpose of the FTP is to protect natural and enhanced stocks against disease problems and unwanted mixing of gene pools.
3. Proposed new regulations for the shellfish mariculture program. At the time of this

writing, these regulations are under public review.

4. Prepared a unified application system for a shellfish farm. One of the problems expressed by the public is the heavy load placed on applicants as they deal with the many agencies involved in permitting. ADF&G, working cooperatively with other agencies, has produced a single application form for ADF&G, Department of Environmental Conservation (DEC), Department of Natural Resources (DNR), and the Governor's Division of Governmental Coordination (DGC). DGC will receive the application form from the applicant and coordinate review. The unified application form is now in the final stages of review.
5. Began to develop information on key issues in anticipation of the 1987-88 legislative session. This effort is being coordinated by ADF&G and involves DEC, DNR, Department of Labor, and the Commercial Fisheries Entry Commission (CFEC). CFEC is involved not from the point of view of limited entry, but of commercial fishery licensing. This information packet will include discussion papers on important issues, an analysis of management systems in other states and countries, and an analysis of selected policy options.

Permit Activity: The Department of Environmental Conservation has issued or is in the process of issuing certification for about 50 shellfish farming operations. Of that number, about ten oyster and mussel operations are producing product for the market. Main centers of production at this time are Halibut Cove Lagoon (in Kachemak Bay) and the Wrangell/Petersburg area. There are several operators in Kodiak, Ketchikan, and parts of Prince William Sound that are seriously working toward producing products in marketable quantities.

Promising Aspects of Mariculture in Alaska

Market: In order for a cultured product to be successful, it should command a high and stable price and be in high demand. For the species holding best promise for mariculture in Alaska (oyster, scallop, and mussel) the situation is encouraging — particularly since the American public is turning to seafood as one way to increase quality of life and health.

Sites for Sea Farms: One of Alaska's great advantages over the "lower 48" for mariculture is its extensive and highly complex shore line. Pollution (including the recent problems with "visual" pollution) seems to be a major obstacle to the continued development of mariculture elsewhere in the Pacific Northwest. Alaska's low pollution levels, together with the many protected coves and bays found in much of the state, show a real advantage in this area. Low population densities suggest that this will not be a problem for some time.

It is important to note that sea farm siting requires careful coordination, particularly in the areas of environment and consideration of alternative uses (subsistence, sport fishing, scenic esthetic, commercial fishing, use as anchorage, and others).

Stability: A successful mariculture industry would use one of Alaska's strongest renewable resources to augment sometimes problematical oil revenues. The "boom-or-bust" nature of Alaska's industries is frequently mentioned. Sea farming has the potential to create a steady economic benefit to the state.

Benefits to Rural Alaska: Since mariculture operations require remote siting and a fair amount of year-round labor, it is expected that coastal rural Alaska will receive a large share of any economic benefits coming to the state through mariculture.

Growth Potential: Mariculture is a growing industry. Even in countries where it is a major force, sea farms are a relatively recent development. There is good potential for increases in profit margin, ease of operating the farms, safety to the plants and animals being farmed, and for reduction of negative visual and environmental effects. Areas of promise are: advances in equipment technology (feeding, cleaning of cages, flotation systems, handling of product) and technical advances in biological areas (genetic engineering, inexpensive seed production from hatcheries, new species/polyculture development).

Working in coordination with the commercial fishing industry, innovative combinations of mariculture and commercial fishing can be developed. For example, one of the most profitable aspects of mariculture involves seeding some selected sections of the ocean floor with small scallop. Subsections of

Shellfish Mariculture *continued*

that area are then harvested by commercial fishermen, a plan similar to crop rotation.

Problems and Challenges

PSP: Bivalve shellfish are filter feeders and, as such, are capable of concentrating the toxin from several species of free-swimming microscopic organisms. The result can be Paralytic Shellfish Poisoning (PSP). The problems with this are primarily associated with human health, expense, loss of shelf life, and logistical problems involved with testing to make sure that a particular shipment of product does not have PSP toxin above tolerance levels.

One of the advantages of scallop culture is that the traditional product form (shucked adductor muscle) does not have appreciable amounts of toxin and can be marketed with a minimum of testing for PSP.

One need of the industry is for more efficient PSP testing, particularly for southeast Alaska.

Siting: Remote site locations may be necessary to get good water quality and to get away from conflict-prone high-use areas. However, the remote sites have problems from the point of view of getting and supporting workers on site, getting the products to market, and general logistics (maintenance service, supplies, etc.). Site selection must consider trade-offs between these factors.

Seed Supply: A basic need for any farm is an inexpensive and reliable seed supply. Shortage of seed is one of the reasons that shellfish mariculture in Alaska has not grown more quickly. Options are to purchase from a hatchery or capture from wild sources.

A joint ADF&G/OFCF project now under way in Kodiak is testing feasibility of capturing weathervane scallop spat using spat collectors developed by the Japanese scallop farmers. OFCF (Overseas Fisheries Cooperation Foundation) is a quasi-government Japanese foundation funding projects whose objective is to promote international goodwill. Other similar but smaller-scale projects are under way in various parts of the state.

Economics: The profit margin for a shellfish farmer may be narrow. To operate a successful business, the farmer must have a good financial plan, including an understanding of the critical economic parts of the farming operation. Examples are minimizing equipment cost, controlling logistic problems, getting best use of labor, and effective marketing.

Disease and Genetics Issues: These issues are not cause for serious concern as long as proper safeguards and programs are in place (inspections, lab support, etc.). In general (providing that there is no introduction of exotic stocks), any disease threats from indigenous stocks can be dealt with using existing policy and procedure. Review and policy adjustments are ongoing, as the resource agencies accommodate these new programs.



Mike Kaill examining kelp near Kodiak Island.

A Quick Look at Alaska Mariculture by Species

Scallop: here are several species of scallop in Alaska. Scallop of interest to mariculturists are: the weathervane (*Patinopecten caurinus*), the purple-hinge rock scallop *Crassodoma (Hinnites) gigantea*, and two or more species collectively called "bay scallop" (genus *Chlamys*). Of these, the large, commercial weathervane is of great interest. A close relative is the basis of the rich scallop culture in Japan. The weathervane has a high demand in the U.S., commanding a consistently high price based on product from the trawl fishery. The purple hinge is not commercially taken, since it is sparsely (though widely) distributed. If a hatchery program for seed could be initiated, this species, with growth and product quality close to the weathervane, could show much promise.

However, the bay scallop complex, composed of smaller, slower growing scallops, might be marginal for culture.

Oyster: There is currently a "half-shell" oyster industry in Alaska. Many of the farms are in the Wrangell-Petersburg area, though new interest is appearing in the Ketchikan area, Prince William Sound, and Kodiak. The Alaska-produced product (Japanese oyster, *Crassostrea gigas*) is of high quality. One of the reasons for this is that the oyster is on the edge of its range, and seldom comes into reproductive condition in Alaskan waters. Energy that would go into gonadal tissue is devoted to flesh, creating a plump, yet relatively fast growing oyster. Seed is provided by producers in Washington and Canada, which is a problem because of expense and logistics. The Japanese oyster is presently the only authorized mariculture Alaska import.

Mussel: Although not a common seafood item in Alaska, the blue mussel (*Mytilus edulis*) is a highly prized delicacy in Europe. There is an increasing appreciation for this species in Alaska, particularly when diners realize that the cultured mussel is far superior to the one taken from the beach. Culturing blue mussel has the advantage of readily available seed (dense concentration of spat settlement in some areas) and an 11-month growing season, compared to 2 to 3 years in other species.

Other Species: Other species of shellfish are candidates for culture in Alaska, but are not nearly as strong as the species mentioned above. These include surf clam, razor clam, as well as species not yet authorized by the legislature such as sea urchin, shrimp, and crab.

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Salmon Ocean Ranching in Alaska

by

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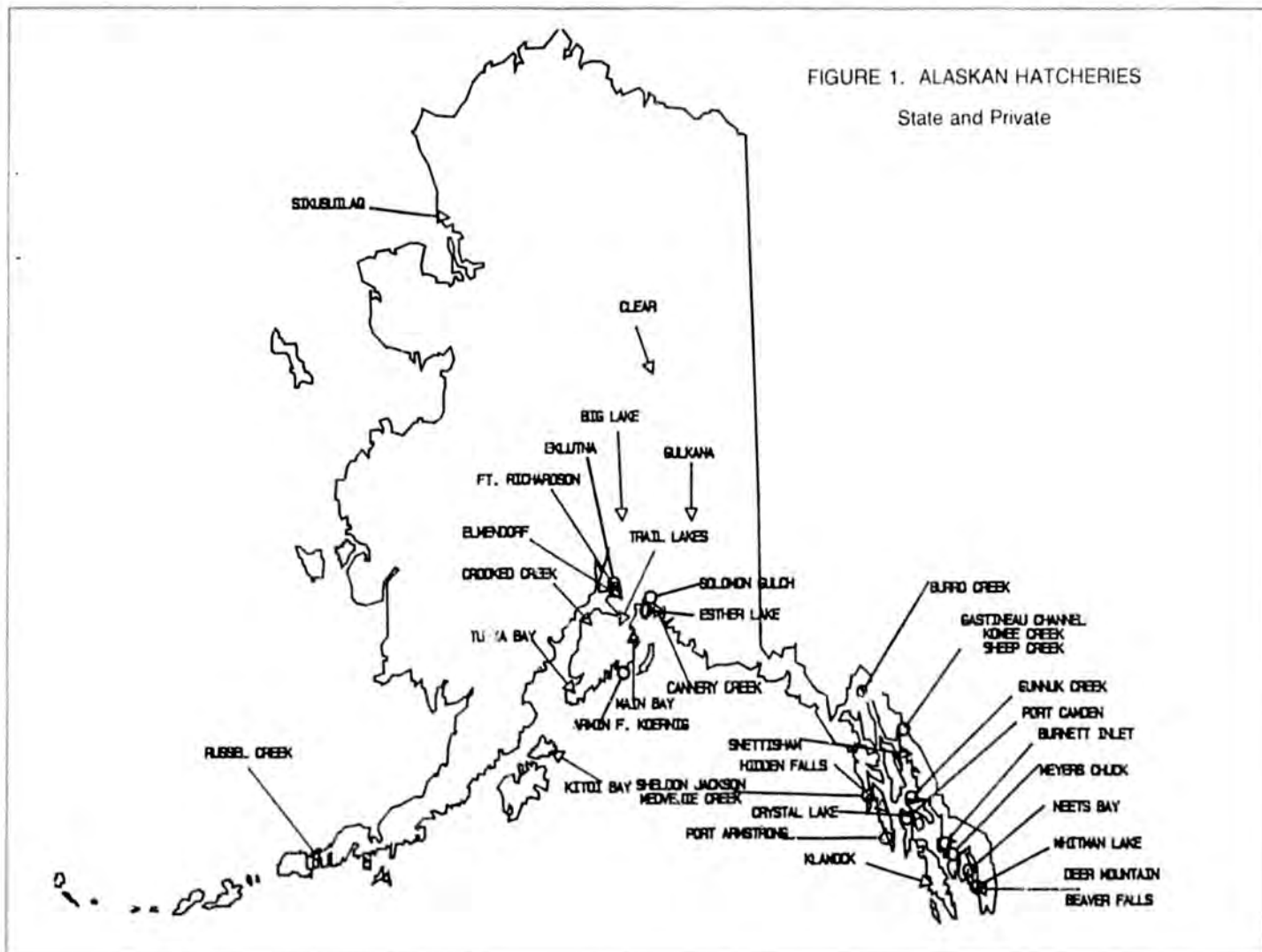
Alaska Department of Fish and Game

Introduction

The largest and most successful form of aquaculture in Alaska is salmon ocean ranching. It was created out of need by the state legislature in the early 1970s when natural salmon runs were depleted statewide. Enabling legislation in 1971 began with a public program and expanded in 1974 to statutes allowing for a private nonprofit sector. Ocean ranching of salmon is an established technology over 100 years old which takes advantage of the fact that salmon "home" or return unerringly to their location of release.

The source of initial production comes from freshwater hatcheries which control the environment such that roughly eight times the survival is achieved over their natural counterparts. This is true because a constant, reliable source of water is applied during the egg to juvenile salmon release phase, as contrasted to natural production which can be severely limited based upon lack of water flow, natural streambed dynamics, and freezing temperature regimes. Depending upon the species' life history strategy, the salmon are released into the marine environment as fry for chum or pink salmon, or as smolts for chinook or coho salmon, or into a freshwater lake as sockeye salmon fry. It is this unique, instinctual migratory behavior of leaving freshwater as juveniles, growing and initiating maturation in the marine environment with the return back to freshwater to spawn that

distinguishes Pacific salmon and sea run trout like steelhead and makes them so economically valuable. This life style is called anadromy and its survival value is obvious in that the richness of ocean pastures can be exploited by what was originally a freshwater fish. Moreover, the fact that salmon specifically return or "home" to their location of release causes aquaculturists to have some control over their migration as if they were on a chemical leash. That the leash is chemical has been determined by many laboratory and field experiments which all prove that anadromous salmon and trout have an uncanny sense of olfaction, or they smell their way home. In the course of going home, these fishes are caught in the commercial, sport, subsistence, and personal-use fisheries and contribute substantially to the social and economic lives of urban and rural Alaskans.



Ocean Ranching *continued*

Present Status

There are currently 19 public hatcheries run by the Alaska Department of Fish and Game (ADF&G), Fisheries Rehabilitation, Enhancement and Development (FRED) Division, and 25 private nonprofit permits with 18 operational hatcheries practicing the technology of salmon ocean ranching throughout Alaska. The scope of the program is bold and worldwide in perspective (Fig. 1). These hatcheries took 1.338 billion salmon eggs last year, plus over 10 million trout eggs (Fig. 2). The Alaskan salmon ocean ranching program is the largest in North America, approximately one-half the size of Japan's and roughly equal to Russian programs. Sockeye salmon production alone is the largest in the world with over 100 million eggs taken. These phenomenal records were achieved from inception in the early 1970s to the present, a relatively short 17 years. As yet, preliminary data suggests that the returns in 1987 from both the public and private nonprofit program account for roughly 18 percent of the total salmon harvest statewide. When the data for Alaskan hatchery returns in 1987 is graphed, it shows that most of the returns to date are from pink salmon, followed by chum and sockeye salmon (Fig. 3). The reason pink salmon ocean ranching has been so successful relates to their 2-year life cycle and the fact that they are economical to raise.

Aside from the biological successes, salmon ocean ranching has had a profound impact on the economic and social structure of Alaskan communities. One study conducted in 1984 predicts that the statewide program will generate net benefits over costs of \$90 million to the Alaskan economy for just the commercial fishery portion of the program. A more recent study to quantify the economic impacts of the ocean ranching program utilizes an impact model developed by the Institute of Social and Economic Research (ISER) at the University of Alaska Anchorage. This model determined that the economic contribution of ocean ranching to resident personal income was \$75 million and over 2,000 resident jobs from fish dollars directly earned in the fishing industry, or by indirect or induced spending in other sectors of the community.

Since these programs produce significant numbers of fish for the sport fishery as well, both economic studies have underestimated the total economic impact. Because values

FIGURE 2. ALASKAN HATCHERY EGG TAKES 1987

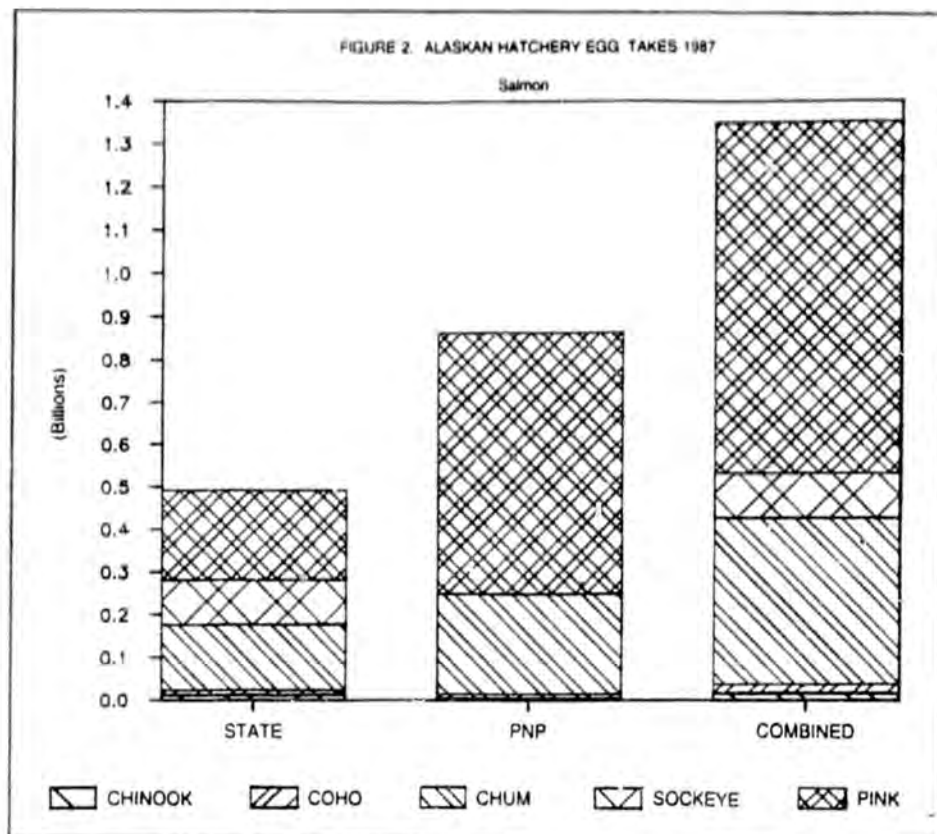
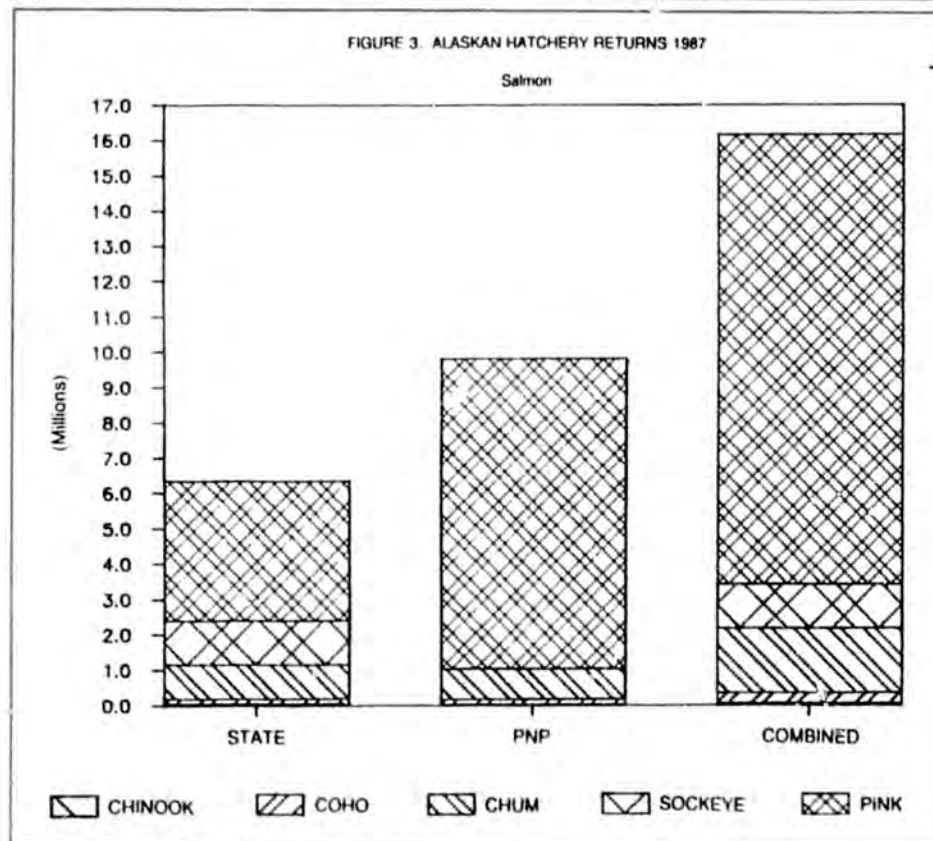


FIGURE 3. ALASKAN HATCHERY RETURNS 1987



Ocean Ranching *continued*

have not been generated for the recreational value, it has been difficult to compute the economic benefit in total to date; when this is done, an even greater economic impact than presently projected will result.

An insight into the scope of the salmon ocean ranching program in the immediate future can be seen in the projected adult return and revenue from the 1988 egg take. Given the generation times of the salmon species involved, this can be two years or 1990 for pink salmon and six years or 1994 for chinook salmon. The projected adult common property fishery harvest of salmon from both state and private nonprofit programs represent roughly 34 million fish and \$76 million in gross revenue (Figs. 4 and 5).

In addition to anadromous salmon and steelhead trout, the public enhancement program (the ADF&G/FRED program) produces substantial numbers of landlocked or resident species, such as rainbow trout, Arctic grayling, Arctic char, sheefish and, most recently, lake trout. The culturing and future production potential of these species is encouraging based upon sport fishermen demand from both resident and tourist sectors.

Salmon ocean ranching in Alaska is an unparalleled biological and economic success and has achieved a world-class status after only ten years of adult returns. On this basis, the full potential of the present program has not been reached yet based upon the capacity of the production systems. It is this production potential in terms of continuing salmon supply that will provide the foundation for Alaska's world market salmon share and help to strengthen the salmon industry against future salmon harvest fluctuations.

FIGURE 4. ALASKA STATE AND PNP HATCHERY PROGRAMS

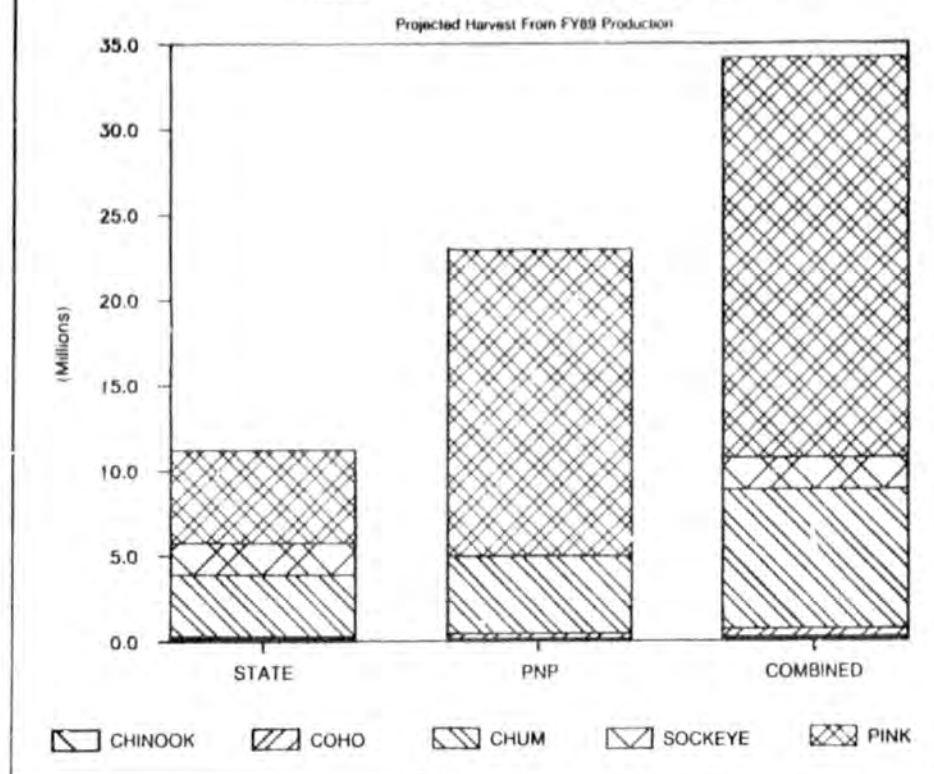
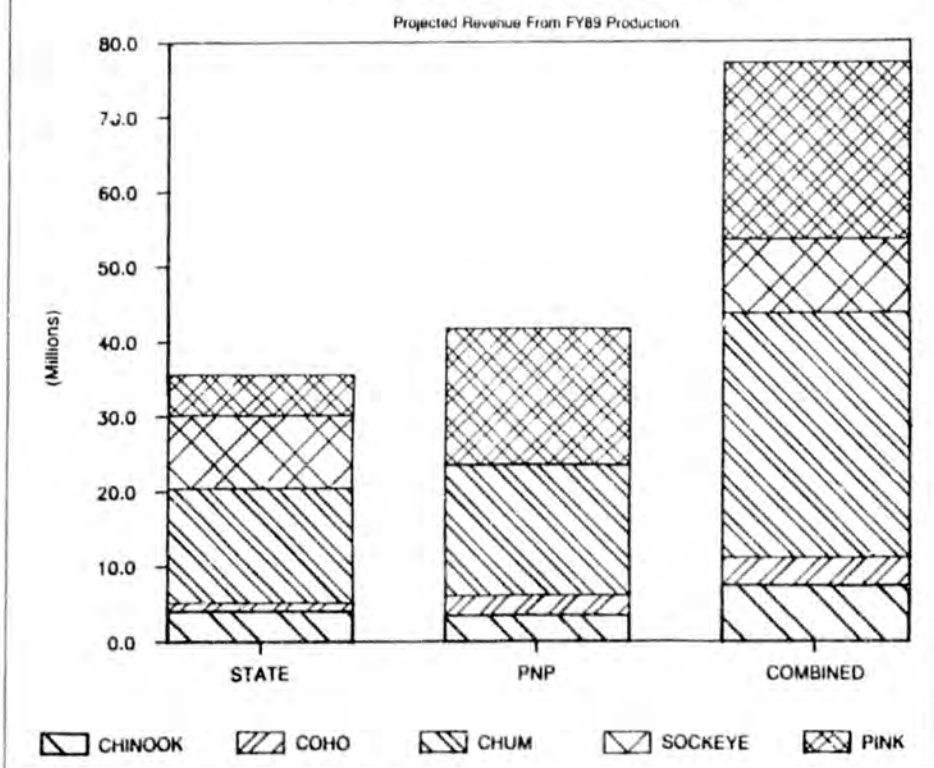


FIGURE 5. ALASKA STATE AND PNP HATCHERY PROGRAMS



Economics of Salmon Farming

by
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The recent debate in the Alaska State Legislature over aquatic farming legislation (HB 108 and SB 106) has been highly emotional and often lacking in basic factual information. The most controversial subject has been whether to allow finfish and, more specifically, salmon farming in Alaska. Conflicting testimony has been offered before legislative committees concerning the feasibility of salmon farming in the state and its potential economic effects on the existing commercial fishing industry. Offered below is some basic economic information on salmon farming and estimates of impacts I have gleaned from a variety of sources in the course of studying this subject for the legislature during the past year.

The worldwide development of salmon farming to date, beginning in Norway in the early 1970s, has largely been a phenomenon of small to medium-sized companies. This has been primarily the result of an 8,000 m³ (cubic meter) pen size limitation in Norway, which was designed to encourage family businesses. As a social policy, the volume limitation has been successful in maximizing employment and improving the economies of coastal communities. However, it has also been a major contributor to disease problems in the Norwegian salmon farming industry as it encourages farmers to use stock pens to maximize returns on their investment. Farmers in Norway routinely produce 200 mt of Atlantic salmon annually within these volume constraints. Farms in New Brunswick or Nova Scotia with a comparable production capacity would typically have 2-3 times this net pen volume and far fewer disease problems caused by stress from overcrowding.

There are substantial economies of scale in salmon farming, though these tend to be tempered by the risk of disease outbreaks in very large single-site operations. To avoid domestic volume constraints, the effects of exchange rate fluctuations, and to reduce shipping costs to primary markets in the U.S., many successful Norwegian aquaculture firms have invested heavily in the burgeoning British Columbia salmon farming industry. About 40 percent of the investment capital in the B.C. salmon farming industry has come from

Norwegian sources, although many other sources of capital (including the Vancouver Stock Exchange) have been used. Aquaculture is now the fastest growing industry in B.C. The result has been an evolving corporate farm type structure (as opposed to small family farms in Norway) to the Canadian industry as smaller operators have acquired investment capital and have purchased others or expanded their operations to multiple sites.

A recent survey of B.C. salmon farms (November 25, 1987) by the Ministry of Agriculture and Fisheries listed 113 operational farms and 38 sites which were licensed but not operational. Average farm volume has increased from 6,767 m³ in 1986 to 20,821 m³ in 1987, while total B.C. farm volume has increased from 466,805 m³ to 2,123,739 m³. Likewise, the average farm holding capacity increased from 53.5 mt in 1986 to 166.6 mt in 1987, and total holding capacity grew from

3,717 mt to 16,990 mt. According to the Ministry of Environment, there are 38 commercial fish hatcheries with a combined capacity of 65 million eggs, although due to limited egg supplies, actual production is less than half of capacity.

Estimates of stock on hand in B.C. farms by species are as follows (in mt):

Chinook	2,768
Coho	1,214
Atlantics	81
Rainbow trout	194
Total	4,257

The cost structure of a typical B.C. salmon farm (Table 1) is presented in terms of the break even cost per pound of operations. Generally, it takes at least 6 quarters between the time smolts are put in a pen until the first harvests begin and the farmer can realize some cash flow. By the time full production is

TABLE 1. COST STRUCTURE OF A 110 mt B.C. SALMON FARM*
(in U.S. Dollars)

Capital Costs		Total Initial Financial Requirement	
Buildings	\$ 22,500	Capital Costs	\$ 157,500
Cages & Nets	75,000	Operating Capital	262,500
Equipment	38,250		
Infrastructure	21,750		
Total	\$ 157,500	Total	\$ 420,000
Operating Expenses		Annual Costs	Cost per lb. Salmon
Smolts		\$ 26,925	\$ 0.12
Feed		150,626	0.67
Disease Control		2,640	0.01
Harvesting		20,024	0.09
Fuel & Supplies		18,000	0.08
Labor		22,500	0.10
Maintenance		4,875	0.02
Management Salaries		26,250	0.12
Communications		6,000	0.03
Insurance		6,000	0.03
Lease Fees		750	0.00
Professional Fees		6,000	0.03
Mortality Insurance		22,500	0.10
Miscellaneous		3,000	0.01
Depreciation		14,813	0.07
Term Loan Interest		9,286	0.04
Operating Loan Interest		1,738	0.01
Total Annual Expenses		\$ 341,926	\$ 1.52

*Source: Canada-British Columbia Subsidiary Agreement on Small Business Incentives.

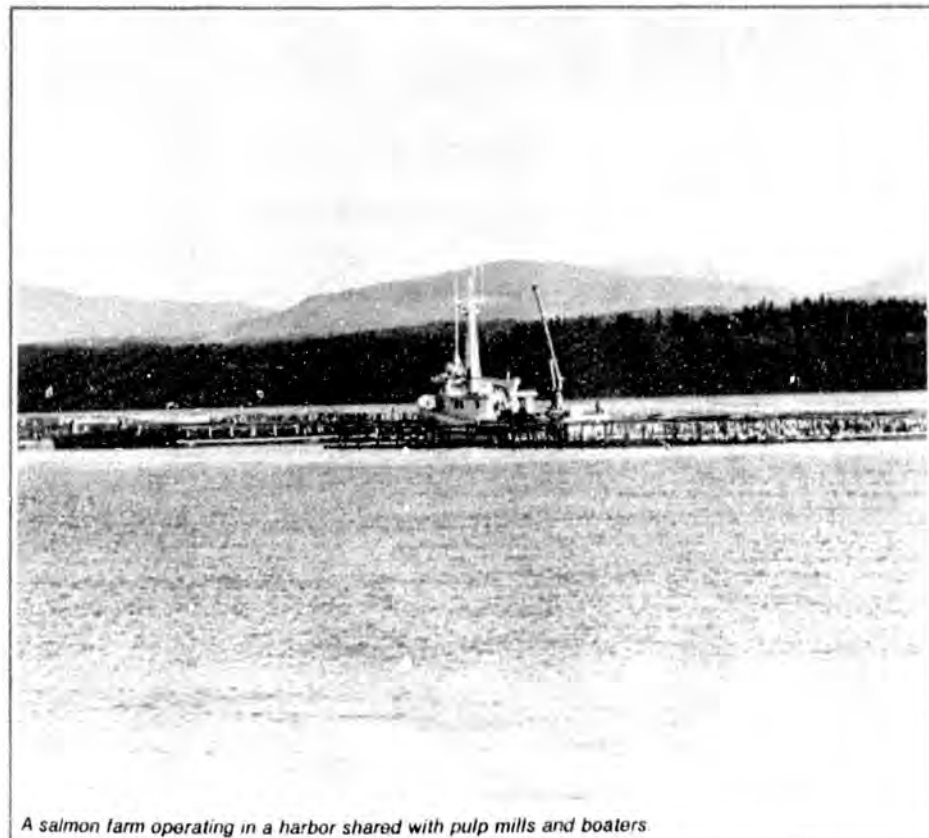
achieved (usually by the third year of operation) the average grower probably has a total investment of \$1 million (U.S.) in the operation. For 4-6 lb. fish, B.C. growers have been receiving farmside prices of \$2.30-\$2.65/lb. producing margins of 50-75 percent (larger fish command higher prices and produce greater margins). Production costs and mortality rates are expected to come down considerably in the near future through greater use of domesticated broodstock and improved husbandry techniques. These factors are likely to increase profitability even as increasing supplies of farmed fish in the marketplace tend to lower product prices.

The focus of the B.C. industry is turning from southern inside waters northward, to outside regions with more oceanic conditions. Colder water temperatures in northern B.C. produce slower growth rates, but these are more than compensated for in decreased mortalities (due to disease episodes and plankton blooms) compared to those experienced by southern B.C. farmers.

Currently the B.C. industry directly employs 544 persons - 318 full-time farm employees, 137 part-time workers, and 89 office employees. Salmon farming employees are not highly paid. The average annual wage assumed in another recent B.C. survey was \$18,000 - similar to wages paid in the seafood processing industry. The major difference is that salmon farming provides year-round employment to local residents, while the seafood processing industry tends to employ large numbers of seasonal nonresident workers. One has only to peruse a copy of the "Canadian Aquaculture Buyer's Guide" to realize that the industry is developing a substantial support sector with local businesses supplying smolts, net pens, feed, consulting and diagnostic services, processing, shipping, and marketing.

The Economic Impact of Salmon Farming in Alaska

During the past year, several attempts have been made to forecast the economic impact of a salmon farming industry (or varying scales of production) in Alaska with wildly differing results. Given the fact that growing conditions in Alaska are very similar to those in northern B.C. and the cost structure of the Canadian industry cited previously, there is little doubt



that salmon farming is economically feasible in the state. Even with marginally higher production and shipping costs, farmers in Alaska should be able to become competitive and realize reasonable profit margins.

A salmon farming industry in Alaska is likely to have purchasing and sales patterns that are similar to the existing fishing industry. For example, purchases of equipment are likely to be made outside the state, while basic supplies such as smolts and feed are more likely to be purchased locally. Alaska will have a smaller support sector than B.C. because the economy is much less mature. The most prudent approach to calculating economic impacts appears to be to assume an effect that is comparable (in proportional terms) to the existing commercial fishing industry. An additional consideration is that much of the capital investment for salmon farming is likely to come from outside the state as it has in B.C. (and as it has in the Alaska commercial fishing industry as well). This means that a certain amount of gross revenues will go to pay debt service and returns to outside investors, which will tend to offset the higher resident wage impact cited previously.

With these caveats in mind, my best guess is that a 10,000 mt Alaska salmon farming industry would produce 600 direct full-time jobs, a payroll of \$9.9 million and gross sales of about \$66 million. Note that a 10,000 mt industry is likely to be several years in the future, although a 4,000 mt industry could be realized within 4 years of the passage of enabling legislation. Purchases of feed from local processors (estimated at \$23 million) and eggs/smolts from public and private hatchery operators (about \$9.6 million) would also ripple through the state economy.

Presently, we do not have a feed plant in Alaska capable of supplying dry feed at economical prices. However, there are sunmi plants in the Aleutians that produce fish meal byproducts (currently sold to Taiwan eel farmers) that could easily convert to supply fish feed at prices that are competitive with feed costs in other salmon farming countries. Surplus salmon eggs from Alaska's ocean ranching program are readily available. In 1986, Alaska's public and private nonprofit hatcheries had 4.6 million chinook and 23.2 million coho eggs that could not be used for enhancement projects under current genetic

Economics *continued*

regulations. These surplus egg supplies vary from year to year, but are expected to remain at substantial levels into the foreseeable future.

Even though there is little evidence of direct price competition between wild and farmed salmon in the existing economic data, there is little doubt that farmed production is rapidly gaining a dominant share of growing premium markets worldwide, while wild production is declining in market influence. About 97 percent of the harvest of premium species in Alaska is marketed in frozen form and only three percent fresh, while almost all farmed salmon is marketed in fresh product form. There is a fundamental consumer preference for fresh fish that is likely to increase in the future as greater volumes of farmed salmon become available. Thus, the market impact of worldwide salmon farming production will occur regardless of whether or not a salmon farming industry exists in Alaska.

Various attempts have been made to model the future market impacts of farmed salmon production on the existing commercial fishing industry, with little success. Salmon markets are extremely volatile and do not lend themselves readily to mathematical modeling techniques. Recently both the supply of, and demand for, fresh farmed salmon have exploded. Seafood markets in general have been very strong worldwide. Farmed salmon is a relatively new phenomenon in the marketplace. In a sense, salmon farmers have created their own markets by offering a high quality product year-round. With such a short market history to trend from and only a vague idea of the potential market size, economists have a difficult time forecasting the market impacts of farmed salmon production with confidence. However, these recent attempts at estimating market impacts are useful in illustrating the relative impact of worldwide farmed salmon production on the commercial fishing industry in Alaska compared to a proposed local salmon farming industry.

We know that demand for salmon products in general is price elastic, i.e., a one percent increase in supply results in a less than one percent decrease in price. Estimates vary widely on the degree of price elasticity. A recent University of Alaska study applied the existing range of elasticity estimates for salmon products to the value of the Alaska commercial salmon harvest, assuming a 100,000 mt

increase in worldwide annual farmed salmon production by 1990. Several simulations were run varying the structure of a salmon farming industry (small vs. large farms) and the substitution effects of farmed for wild species. The worst case scenario forecast a \$36.4 million annual loss in gross revenues to Alaska commercial salmon fishermen, while the best case estimated a \$5.1 million loss.

Using this methodology, the potential market loss attributable to a 10,000 mt Alaska salmon farming industry would range between \$2.4 million (worst case) and \$0.4 million (best case). If we think of these market impacts in proportional terms and relate them to the 1987 Alaska salmon harvest value (estimated at \$458 million), worldwide farmed salmon production could potentially cause an 8 percent decrease in revenues by 1990. By comparison, production from an Alaska salmon farming industry could decrease commercial

fishermen's gross revenues by an additional one-half of one percent.

In conclusion, salmon farming is feasible in Alaska and development would offer substantial economic benefits to the state with minimal incremental impact on the existing commercial fishing industry. Aside from the immediate economic benefits, salmon farming would offer significant spinoff effects as the technology of broodstock development could be applied to the present ocean ranching system. Recently developed diploid techniques, which produce all female fry, seem particularly promising. Husbandry practices developed by farmers could also be applied to other species. Indications are that B.C. growers are 2-4 years away from the commercial farming of black cod, which offers another very large market potential. I hope this information contributes some perspective and clarity to the ongoing debate.



Transferring smolt (from hatchery location) to a salmon farm

Salmon Farming: Gambling with Alaska's Wild Stocks?

by
Alaska Trollers Association

The fishing industry feels the value of shellfish and vegetable culture to the state and local communities outweighs the associated costs. It is these forms of mariculture which will fit into the Alaskan style of life, and economy, with few negative impacts on our existing socioeconomic structure. On the other hand, we strongly oppose the implementation of salmon farming in Alaska. Our opposition rests not on the concern over a single issue, but rather the cumulative effect this proposed industry will have on the state's economy, the fishermen of this state, and our entire industry.

To begin, let's take the issue of what agency in the state government will be charged with the responsibility of regulating this proposed industry and the implications on the protection of our wild stocks. We should first consider that Alaska produces 90 percent of all salmon landings in the United States or 43 percent of the world's landings from wild, natural runs of salmon. While the spread of disease from penned to wild salmon may be of a low order of probability, the potential for major damage to the wild stocks does exist. Therefore, any discussion of this new industry must focus on the regulatory climate which will protect our massive investment, an investment, by the way, which has produced one of the world's most successful ocean ranching programs.

Currently the stringent regulatory safeguards on wild stocks is adequate. Still we are worried that regulations like strictly forbidding the importation of non-indigenous or exotic species of fish, a primary safeguard in our present system, may fall by the wayside because the development of the proposed industry is perceived as more important than the possible effects to the gene pool and disease on our wild stocks. For instance, in Norway this safeguard was circumvented in 1986 with the importation of Scottish smolts. In sidestepping the normal caution of nonimportation, the Norwegians introduced a new disease form into their waters which quickly spread and caused massive mortality to their inventory of fish. Just how much havoc this outbreak caused is hard to determine since there seems to be reluctance on the part of the Norwegians to let the rest of the world know what happened. Closer to home we have

seen British Columbia transfer Atlantic salmon to the Pacific coast. The threat this transfer represents to wild stocks, particularly steelhead, remains to be seen.

We are also worried about the possible effects to wild stocks from escaped pen-reared fish. It has become apparent that these fish do escape no matter how stringent the protections are. For 25 years Norway has been in the farming business and just this spring they discovered that 10 percent of the fish in their streams weren't from wild stocks after all, but instead were escaped farmed fish.

It is interesting to note that the promoters of pen-reared salmon are even now seeking to circumvent prudent regulatory controls. The proposed bills allowing mariculture in the state place the authority for management of the proposed industry under the Department of Commerce and Economic Development instead of the Department of Fish and Game which has the mandated safeguards needed to protect our wild stocks. Our concern with the placement of management is certainly not a reflection of the promoters purported position of wanting strict regulation and safeguards, but a reflection that the management of this prospective industry would be given to an agency with little experience in the biological and technical basis needed to protect our wild stocks and current industry.

Actions and incidences such as the introduction of exotics raise the question of how a private, for-profit industry will impact our wild runs of salmon and whether the profit motive will cause the industry to try to evade prudent regulatory safeguards in the interest of short-term profits.

The cumulative negative effect of salmon farming is again typified when one asks the question of where the resources will come from to manage this prospective industry. Herein lies one of our major concerns with the mariculture industry. Proponents suggest that their industry will take little from the existing system but as most of us know there are no free lunches out there; you just can't get something for nothing as the fish farm promoters suggest. There will have to be government programs created or expanded to regulate fish farming practices and these regulatory programs will cost money and state resources. It is a safe bet that the money and

resources won't come from an increasing state budget and we know the new operations won't be paying taxes until they start showing a profit, which will be many years down the road.

As you may know, state agency funding is determined by using one of two criteria, either through what is called formula funding or discretionary funding. Formulas are used to determine funding levels for such agencies and programs as the Department of Education and municipal revenue-sharing. The monies left over after formula funding are termed discretionary funds. Discretionary funds are what currently run agencies like the Department of Fish and Game and the Department of Natural Resources; these funds are determined by our policy makers every year at budget time. To many, a fish is a fish; therefore, it is a safe bet that the funds to run this proposed industry will come out of the current fish management programs. These are the same programs that are producing such a high rate of return to our state's economy, the same programs that are already being cut to the bone because of revenue shortfalls.

The question then is what happens when an agency such as the Department of Fish and Game sees budget reductions; it affects their ability to make accurate resource management decisions. Because of the lack of information on which to base sound management decisions, there is the tendency to manage the resource conservatively. This may appear good for the state, and is how any prudent manager would respond, but when one considers that a portion of the resource has been wasted when it could have been harvested, it becomes a loss to the fishermen and our economy. For example, a recent analysis done for the Bristol Bay fishery indicated that for each additional \$86,000 put into the management program, management error decreased by one percent. In this fishery one percent represents a direct loss to fishermen of \$2.75 million. In this instance if the funds had been available to reduce management error by the required one percent the economy would have seen at least a 3,000 percent return on investment. We might also point out that this doesn't include losses to other segments of our economy in which these dollars would have circulated if the resource had been optimally managed.

Salmon farming has become one of the most controversial subjects within the fishing industry this year. The following articles explain two opposing viewpoints on the issue.

If, by chance, mariculture management funds don't come out of fishery management funds, they'll come out of things like hatchery funding. This would be the ultimate irony - because if salmon farms get hatchery money, then fishermen will have to make up any deficits with mo.s assessment taxes to themselves in order to keep these hatcheries open. In this case, fishermen would be financing the fish farm industry, an industry they don't want in the first place and in fact would be in direct competition with them.



A fisherman picks wild salmon out of his gillnet on the Copper River flats.

Along with the guise of strict regulation and limited use of the states decreasing management resources, proponents of pen rearing like to say that their industry will provide a boost to our state and local economies. It should be pointed out that our current fishing industry already employs approximately 50,000 people directly, this does not include employment in associated support industries in all segments of our economy. We don't feel that salmon farming can even come close to the positive impacts the current industry has on our state, and in fact the economic impact this proposed industry will have is the transfer of jobs and wealth from an established segment of the economy to a new, smaller group who may not even be Alaskan residents. Although proponents are selling the concept that the farms will be owned and run by local residents and be typical of small business like your local fisherman, or grocer, the real world depicts a different reality. Small, locally-owned operations won't have a

chance. Because of the startup and operating costs involved, mom and pop type Alaskan operations may be able to get their food in the door, but it is doubtful that they could stay afloat if hit with a disease outbreak or a downturn in the industry which all experts project in the next 3-5 years. In fact we would submit that if fish farming were to come to Alaska we would see the industry dominated by a few wealthy individuals and multinational corporations predominantly from Norway. As with any other industry, as it progresses through its life cycle more technology is required in order for businesses in that industry to remain profitable. Technology usually means a more capital intensive industry with fewer employees. This type of industry is certainly not what most of our local community members can afford or are being promised.

At a seminar in Seattle, John Spence from Hardy Seafoods, a thriving mariculture company in British Columbia, told the audience that "mom and pop operations were just a dream." He said these small operations are being bought up by larger organizations and that by 1990 the industry in B.C. would be controlled by 20 or so large companies.

In the October issue of E.C. Business, an article titled "The Norwegian Connection" states that since Canadian banks aren't willing to advance funds for mariculture development, Norwegian financial offers are eagerly accepted, and the Norwegians are now estimated to control 60 percent of the industry in British Columbia. These financing packages also contain clauses which require the farmer to buy building facilities and supplies from Norwegian suppliers. The article goes on to state that should reality fail to live up to projected goals, the Norwegians could call in their mortgages and end up owning the industry in B.C. outright.

As mentioned above the isolated issues are bad enough but cumulatively they increase the damaging effects to our existing industry. In no other way is this point exemplified more than the issue of competition between product forms.

Proponents profess first, that their product will not compete with our wild-caught product for a share of the world market. Second, that even if Alaskan pen-reared salmon did compete with our wild product this competition would be such a small increment that it wouldn't make that much difference, and finally, that world seafood consumption is

increasing. Our response to their first claim is we must realize that there is only one market for fish products in the world; fish of all kinds compete on this market. Since the volume of pen-reared salmon projected by 1990 will triple, salmon farm producers will look to new markets and product forms to keep pace with production. In order to remain profitable, they will have to try to take traditional markets away from our wild-caught product. For instance, farmers in Alaska will attempt to target markets like Japan which currently consumes 84 percent of our frozen salmon each year.

Secondly, as the supply of all fish products increases, the price paid by the consumer will decline. As with all products, price is directly related to available supply. Since Alaskan pen-raised salmon will compete in the world market, as any product, the increases in production will have a direct effect on the current price of the product and certainly an effect on ex-vessel prices.

Finally, with regard to the fact that worldwide seafood consumption is on the increase, it must be borne in mind that we are primarily concerned with the consumption of salmon and not of seafood in general. The market for salmon is a much more limited demographic market and even though it will share in the general increase in consumption the increase won't be to the extent that mariculture proponents would lead us to believe.

Pen-reared salmon production will cost the fishing industry through lost management, fisheries enhancement, and possible harmful effects on our wild stocks. It is ironic that not only would we pay for production through losses to our existing industry, but that product which we inadvertently help produce will further cut into the existing economy by competing with our wild product in the world markets.

Mariculture proponents are fond of saying that we have a right to fail. We, the fishermen say yes, but not at our expense. We have in Alaska the last great wild salmon runs in the world, these runs are the second largest revenue generators in this state and are proving to be Alaska's true Permanent Fund. Pen-reared salmon compete with this resource and dilute the value of our already massive investment. No one can say for certain that no harm will come to our wild stock from pen-reared fish. It just doesn't make good economic sense to gamble with our industry's future knowing what the stakes are.

Salmon Farming: Bright Star for Alaska's Future?

by
Rodger Painter
Executive Director
Alaska Mariculture Association

Few issues in recent memory have sired a stronger debate in the seafood industry than proposals to remove the legal roadblocks to development of salmon farming in Alaska.

The Alaska Mariculture Association believes fishermen should not feel threatened by Alaska salmon farms.

A host of arguments have been raised against salmon farming, but the strongest objections involve concerns about the impacts on markets and threat of disease spreading from farmed stocks to wild populations.

Market Impacts

Nothing in the debate over mariculture has been more elusive than a common vision of the marketplace.

Opponents of salmon farming in Alaska contend the new production will add to an impending glut of world salmon markets and help drive down dockside prices. Advocates dispute this monolithic vision of the marketplace, saying that markets for cultured and wild products are discrete and there is little overlap. This means Alaska farmed salmon will compete directly against foreign imports, not traditional markets for wild salmon.

One group of researchers from the University of Alaska (UA) surveyed U.S. seafood buyers and concluded worldwide production of farmed salmon appears to have had a relatively minor impact on domestic demand for Alaska salmon. UA economists also completed a study showing Alaska salmon farms should have a negligible effect on salmon markets, but worldwide production could result in a significant lowering of price.

These conclusions have been bolstered by the record value of this year's salmon catch. According to preliminary figures, Alaska salmon fishermen were paid in 1986 a record \$461 million for 90 million fish, the smallest harvest of the decade. This is in sharp contrast to the 1985 record of 147 million salmon worth \$389 million.

These price increases come at a time when the overall imports of farmed salmon into the U.S. continue to increase, despite a drop in Norwegian production.

U.S. Consumption and Market Trends

Virtually all marketing experts agree the hottest seafood market is the United States. National Marine Fisheries Service (NMFS) statistics show the per capita consumption of seafood rose from 12.9 pounds (finished weight) in 1981 to 14.7 pounds last year. While a 1.8 pound gain doesn't sound like much, the increase means Americans ate 582 million pounds more seafood in 1986 than they did only five years earlier. That represents a 20 percent growth in market volume.

In the past, U.S. consumption of salmon increased slowly from .1 pound per capita in 1970 to .4 pound per capita in 1980. Increased supplies from Alaska and Norway then boosted that figure up sharply to .8 pound in 1985, but a drop in landings in 1986 pushed that figure back down to .5 pound, according to Pacific Fishing magazine.

Some analysts say consumption of salmon probably would not have fallen and overall seafood consumption would have been much higher if more seafood was available.

Domestic fisheries landings appear to have leveled off, and foreign producers seem to be the primary beneficiaries of improved seafood markets. Fishermen are earning more for smaller catches, but the primary effect of the laws of supply and demand has been to push up seafood import's alarming rates: imports of edible fish and shellfish increased by \$1.8 billion or 58.6 percent over the five-year period. These forces have resulted in a U.S. seafood trade deficit of \$3.5 billion in 1986, a 79.6 percent increase in five years.

The people who sell most of Alaska's salmon production appear to agree that Alaska's involvement in salmon farming does not pose problems for sales of wild salmon. Processing company officials testifying before the Alaska legislature or quoted in the industry and general news media generally voice concern about the growth of salmon farming worldwide, but discount the impact of Alaska's participation.

Ward Cove's President Alec Brindle says: "The Norwegians with their fish have nearly taken the U.S. market over. It's affecting our markets, but at the same time our market is growing. It's a question of whether or not the market can grow to accept the increased capacity. Frankly, I don't see how Alaska can stand still while the market passes it by."

Important to consider when debating the market impact of Alaska salmon farms is the fact that some major Alaska seafood companies already are purchasing farmed salmon to satisfy consumer demand. Super-market ads and restaurant menus in Anchorage show Norwegian salmon has even achieved substantial penetration of in-state markets. These are the fish that would be displaced by salmon farms in Alaska.

A Fairbanks resident interested in farming cohos recently observed that the only salmon available most of the year in the Interior city is imported from Norway. "How would commercial fishermen be hurt if I try to displace it from seafood counters?"



Nets are stretched over fish pens to keep birds out.

Disease Threat Differs Little from Hatchery Operations

An irony of the current debate over salmon farming is that the salmon industry is beginning to tout the virtues of Alaska's "wild" product. While this may have an appealing ring with consumers, the new tag doesn't jibe with the increasing percentage of the catch accounted for by fish released from private and state hatcheries.

The aquaculture component of Alaska's salmon production is becoming significant. In fact, state biologists estimate about 70 percent of Prince William Sound's record 25.6 million pink catch this year came from area hatcheries. Just what percentage of the

statewide harvest will come from enhanced stocks is unclear, but it should be significant and is likely to get larger in coming years.

More than 1 billion eggs were taken by Alaska's public and private hatcheries during 1986 and that number is increasing.

These massive numbers of eggs are taken to hatcheries and handled in ways identical to salmon farming facilities, except the juvenile fish are released to intermingle with wild stocks, often after short-term stays in salt water net pens. Farmers simply hold the fish in net pens to adult size.

These similarities are critical because private and state hatcheries have a very good track record in dealing with disease, and there have been no indications of infections spreading to wild stocks. One of the strongest objections many fishermen have to salmon farming is the potential risk of spreading disease from pen-reared fish to the wild and enhanced salmon runs.

While no person would argue salmon farming poses no risk to wild stocks, most scientists agree the disease threat of pen rearing differs little from ocean ranching.

Brian Allee, former president of Alaska's most successful private hatchery system and Director of Alaska Department of Fish and Game (ADF&G) Division of Fisheries Rehabilitation, Enhancement and Development (FRED), told a House Resources Committee:

"The Alaska Department of Fish and Game feels that a fish farm and a PNP (private non-profit) hatchery are functionally similar in terms of the biological concerns. And since all PNP hatcheries require permits, by way of consistency, so should all fish farms. Based on this assumption, the statewide disease and genetics policy should be applied to the fish farm permit, in order to reduce the risk of damage to the wild stocks of salmon, which are a common property resource. Both policies have been well developed and implementation of these policies will serve as more than sufficient control."

The most comprehensive U.S. scientific study of the effects of mariculture conducted to date (*The Environmental Effects of Floating Mariculture in Puget Sound*, by Dr. Donald Weston, for the University of Washington) downplayed the potential disease threat of salmon farming:

"While fish held in culture are likely to show more frequent appearance of disease than wild fish, disease does not appear to be transmitted to the wild populations. The bacterial diseases of salmonids in mariculture are not transmissible to humans... Increased bacterial abundance in sediments beneath a mariculture facility is quite probable, but it has not been demonstrated that this increased abundance is of any significance in terms of human health."

Control of disease is one of the challenges inherent in aquaculture and other forms of animal husbandry. The concerns voiced now by opponents of salmon farming are very similar to statements by some fishermen when Alaska's salmon ranching program was being debated in the legislature during the 1970s.

The success of Alaska in dealing with disease problems and the resulting strong support of fishermen testify to the ability of salmon culturists to effectively deal with disease.

Alaska has one of the world's best salmon aquaculture disease management programs, but even the best procedures do not completely erase the threat of disease. Many fishermen will recall serious outbreaks of disease in Alaska hatcheries which led state managers to destroy diseased brood stock and, in some cases, start all over again. But, these problems have been overcome and these same hatcheries are unqualified success stories with no apparent effect on wild stocks.

Salmon farmers also are likely to have reoccurring disease problems, but are showing the industry can respond quickly to those challenges. The large losses of Norwegian farmed stocks to the Hitra disease this year provides a prime example. The National Marine Fisheries Service reports that a new vaccine for Hitra already is being used by Norwegian farmers and the smolt surviving the outbreaks have built a resistance to the disease and are in high demand.

Some critics have questioned whether disease management practices such as the use of antibiotics would affect other marine organisms or lead to the development of disease-resistant strains of bacteria. Most scientists discount these theories, saying the levels of antibiotic usage will be so low that it won't be measurable in the marine environment and, even if it was, the selective

build-up of disease-resistant organisms is highly improbable.

The effect of salmon farming upon water quality is another issue raised frequently. The experience of two of the largest and longest operating salmon farming facilities in the U.S., as described by Bill Waknitz of the National Marine Fisheries Service, is:

"Domsea Farms has a very large facility in Clam Bay, Washington, near the town of Manchester.. This facility is not only 5.4 times larger than the Norwegian size limit, but is thought to be the largest single salmon farm in the world, and it has been in continuous operation for almost 15 years. This facility is located 300 yards from the end of a pier owned by the United States Environmental Protection Agency (EPA). Attached to the end of this pier is the National Marine Fisheries Service net pen research complex. This is the largest net pen research system in the U.S. seawater intake for the EPA Region 10 Water Quality Laboratory is located at the end of this pier, 20 feet from the NMFS facility and 300 yards from Domsea Farms. The water drawn through this intake is used by EPA as the clean reference water against which samples of suspected polluted marine water are compared, through a variety of laboratory tests... If the water quality in Clam Bay were adversely affected by the presence of the giant Domsea facility and the NMFS complex, EPA would take remedial action."

Tests on the Domsea farm by the EPA reveal that sediments under the net pen complex are only two inches deep and extend no further than 100 feet from the pens. The EPA compared the effect of the farm on the sea floor with that of a dock.

This information does not suggest that the concerns of mariculture critics should be dismissed. To the contrary, these scientific findings point out that the biological and environmental problems posed by mariculture are manageable if proper siting and culturing practices are followed.

Alaska's ocean ranching program has encountered only minimal problems because of a conservative approach. These policies should be imposed upon mariculture operations in Alaska to ensure we continue to enjoy the benefits of the state's most important natural resources - its abundant fisheries resources.

Environmental Effects of Mariculture

by

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The evaluation of floating mariculture facilities in Alaska is needed to determine if there are any environmental effects resulting from these operations. There have, however, been studies of mariculture facilities in Washington's Puget Sound. From that, insights into potential environmental effects from floating mariculture can be gained.

Based upon Puget Sound studies, Weston (1986) suggests floating mariculture operations may result in one or more of the following potential environmental effects: (1) accumulation of organic-rich sediments beneath the facility, (2) changes in water circulation, and (3) changes in water quality. In addition, predation problems can arise if not properly addressed in the operation of the facility.

Probably the most common environmental effect associated with floating mariculture is accumulation of organic-rich sediments in the form of wastes, uneaten food, and shell debris on the benthic substrate below the facility. Møller (1976) found that the magnitude of pollution (feed loss and excrement) from a Norwegian fish farm using fresh or wet feed can reach 60 percent of the total amount of food used. Such deposition can result in physical and chemical changes in the natural bottom sediment (Milne, 1979). Included in these changes are increased oxygen consumption within the sediment and increased concentrations of total volatile solids, total organic carbon, sulfides, nitrogenous compounds and phosphates (Weston, 1986). Although Weston (1986) reported that organic-rich sediments occurred around most culture facilities reviewed, the depth of the accumulations depended upon the water depth and current velocities. In general, he found that accumulation of sediments can be expected beneath any culture facility located in less than 15 meters of water. Accumulation of such sediments and the resultant oxygen depletion in the interstitial water can have effects upon the infaunal invertebrate community. Loss of species that are intolerant of organic enrichment (such as echinoderms, crustaceans, and molluscs) often occurs (Weston, 1986). In addition, impacts to bottom vegetation such as eelgrass beds can be expected if facilities are sited over such areas.

Conversely, such mobile species as fish and crabs can be attracted to culture facilities. Romero et al. (1982) reported that the highest densities of crabs in Ria de Arousa, on the northwest coast of Spain, were associated with mussel culture rafts. Pease (1977) found crab and fish species more abundant under culture facilities in Puget Sound than in control sites, and Beveridge (1984) mentions high densities of wild rainbow trout observed around Scottish fish rearing facilities. Increased numbers of crabs and fish under and around culture facilities are probably a result of abundant food supply and possibly cover opportunity.



A farm worker hand feeds penned salmon.

Any anchored floating facility can be expected to somewhat alter water circulation in its immediate vicinity, and floating mariculture operations are no exception. Milne (1979) reported that studies done on Japanese floating fish farms showed reduced currents within the pens as compared to the surrounding water. The effects of these circulation changes are generally minimal but can result in increased sedimentation below the facility when water velocities are reduced and any suspended material is dropped (Beveridge, 1984).

Changes in water chemistry can also result from mariculture operations. These changes are usually an increase in ammonia concentrations and decrease in dissolved oxygen (Beveridge, 1984; Weston, 1986).

Normally these changes do not cause a problem unless the facilities are sited in areas of extremely restricted flushing or in areas of intense mariculture operations which is beyond what would be expected in Alaskan locations.

Proper siting of facilities can usually address the effects discussed above. Floating mariculture facilities should be located in well flushed locations with water depths adequate to prevent grounding at all tidal stages. Sensitive marine habitats such as eelgrass beds or the mouths of anadromous fish streams should also be avoided.

Predation is a common problem with mariculture operations throughout the world. The list of predators includes all types of fish or shellfish-eating mammals, fish and birds (Lindberg, 1976; Milne, 1979; Beveridge, 1984). Usually precautions such as installation of screening or netting will significantly reduce losses. However, if large numbers of predators are present, predator control can become a problem. Given the undeveloped state of most potential mariculture sites in Alaska, predation might be expected from such important mammalian species as mink, marten, otters, seals or sea lions. To reduce potential predation problems, especially from seals and sea lions, care should be taken to avoid known concentration areas such as haulout locations.

Currently, there are no formal guidelines or siting criteria intended to minimize environmental effects for mariculture facilities in Alaska. Instead, each application is evaluated on a site-specific basis through the state's interagency review process for projects in the coastal zone. During reviews, the Departments of Fish and Game, Environmental Conservation and Natural Resources, among others, evaluate all aspects of the proposal, including potential environmental effects.

To improve this process, an interagency team is developing criteria for identifying sites where mariculture facilities would be most suitably located. Included in the criteria will be consideration of competing uses, the physical and ecological requirements of mariculture sites, and human-use patterns. It is hoped that guidelines can be established which will provide potential mariculture operations with sites that have the necessary physical and biological attributes, but which

Criteria for Establishing Salmon Farms

Environmental Effects

continued

cause minimal social and environmental conflicts.

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by

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The prospect of pen-rearing salmon in Alaska has become one of the hottest topics in the state. From fish camps, to city hall, to the legislature, the topic of whether or not to allow salmon pen-rearing is causing a heated debate.

The market success of the Norwegian salmon farming industry and the growth worldwide in fish farming generally have spurred interest in pen-rearing salmon in Alaska. During the 1987 session of the Alaska State Legislature, bills were introduced to legalize salmon pen-rearing. Senate Bill 106 and House Bill 108 would "encourage the establishment and growth of an aquatic farming industry" in Alaska. The bills would establish a permit system which would be administered by the Department of Commerce and Economic Development for aquatic farms and private-for-profit hatcheries.

In response to this action in the legislature, Governor Cowper directed the Fisheries Cabinet to review the mariculture issue and prepare a recommendation to him. The cabinet prepared for the governor a set of criteria for judging any authorizing legislation. The governor approved these criteria, and they were presented to the legislature.

The governor's position stated that mariculture may provide substantial economic benefits to our coastal communities and help diversify and stabilize our economy if it is developed in an orderly fashion which provides the maximum benefit to Alaskans. The governor emphasized that we must ensure protection for our fisheries resources, other resource users and the environment.

The governor then set out eight points which he felt legislation must satisfy to meet these goals. These are:

1. **The mariculture industry must benefit Alaskans.**

The mariculture industry must be developed in a manner which does not result in unfair competition with existing fisheries or cause undue economic

displacement in our coastal communities. Legislation should, to the extent possible under the law, provide for local hire at mariculture facilities and give preferential access to mariculture permits and mariculture related tidelands leases to Alaskans.

2. **The mariculture industry must pay for itself and the state should get a fair return for the use of state resources.**

Legislation should contain provisions for recovering administrative and other state costs associated with managing the industry. The legislation should also ensure that the state gets a fair return for the use of tidelands and other resources.

3. **The development of the mariculture industry in Alaska should be done in an orderly fashion which encourages a stable, dependable industry.**

Legislation should provide general criteria which will lead to the development of a regulatory program which discourages speculation on permits and tidelands leases, encourages sound financial planning, and provides for a diverse industry ranging from "Mom and Pop" ventures to larger corporate operations.

4. **The mariculture industry must meet all state and federal requirements for human health, product quality and sanitation.**

Legislation should ensure that mariculture facilities meet all state and federal requirements for human health, safety, and sanitation. Legislation should also require that mariculture products meet or exceed all state and federal product quality and human health standards, and provide the means to ensure that state regulators can protect human health and product quality.

5. **Mariculture activities must be managed to ensure protection of the biological integrity of natural plant and animal stocks.**

Legislation must address the issues of pathological and genetic protections for natural sea vegetable and fish stocks.

6. Mariculture activities must be managed in a manner which ensures adequate environmental safeguards and habitat protection.

Legislation must ensure that mariculture facilities are sited, designed and operated to protect air and water quality, to provide for proper disposal of wastes, and to minimize adverse effects to important fish and wildlife habitat.

7. Mariculture facilities must be sited to minimize land-use conflicts, maintain navigation and ensure access to upland areas.

Legislation should provide guidance for siting facilities to minimize conflicts with other tidelands users, reducing visual and aesthetic impacts, maintaining navigation and ensuring access across state tidelands.

8. Broodstock acquisition for mariculture purposes should be carefully regulated, especially for species subject to limited entry fisheries.

- Legislation should contain provisions limiting the acquisition of broodstock for species subject to limited entry fisheries.
- Legislation should grant the Department of Fish and Game the authority to regulate the acquisition, transport, and propagation of mariculture broodstock, and provide the Board of Fisheries the ability to resolve allocation decisions regarding broodstock acquisition if necessary.

Last March, the House Resources Committee held extensive hearings on House Bill 108. As expected, the bill generated considerable controversy statewide with proponents arguing that mariculture represented a significant new economic opportunity for Alaskans; and opponents expressing concerns over the potential effects on wild fish stocks, restrictions on traditional uses of our coastal areas, and a loss of income from existing commercial fisheries.

Late in the session it became apparent that authorizing legislation was not going to pass. All parties became concerned that the questionable legal status of pen-rearing salmon could lead to speculation on tidelands sites and a "gold rush" mentality similar to the

situation which developed in British Columbia. The resulting confusion and inevitable litigation would not be to anyone's advantage, so a carefully crafted moratorium bill was introduced and passed in the waning hours of the session. This bill (Senate Bill 297) placed a moratorium which expires July 1, 1988, on issuing permits for most finfish farming. It also authorized shellfish farming and limited finfish farming in fresh water.

At the close of last session, the legislature established an informal workgroup to continue working on the mariculture issue. This group included Senators Eliason, Duncan, and Zharoff and Representatives Hermann, Ellis, and Pearce. The administration has continued to work on this issue under the auspices of the Fisheries Cabinet.

In May, following the end of the legislative session, the Fisheries Cabinet identified two major tasks to be performed over the interim. First, the cabinet agreed that a consistent and uniform permitting program for shellfish mariculture needed to be developed and implemented. Second, the issues identified

during last session needed to be addressed in a systematic fashion.

Given these two tasks, the agencies set about to develop a shellfish permitting program. This has involved developing a new shellfish farm permit from the Department of Fish and Game and streamlining existing permitting procedures under the Alaska Coastal Management Program. This will result in a package where the prospective farmer will be able to secure most state permits through one application instead of going to numerous agencies.

At this time, the administration is working on a number of fronts on the broader issue of finfish mariculture. The resource agencies have gone through an extensive process to identify the key outstanding issues which remain to be resolved. Research is being conducted to see how these issues are addressed in other parts of the world, most notably British Columbia, Washington, California, and Maine. These areas were chosen because they offer a range of management systems and have social, economic and biological characteristics similar to Alaska.



Washington state salmon pens anchor in a nonresidential area.

Selecting a Site for a Salmon Farm

by

Curt Kerns
Aquaculture Specialist
University of Alaska
Marine Advisory Program

Salmon farming, an endeavor that began in the Pacific Northwest, has become one of the fastest growing industries in neighboring British Columbia, as well as in a number of other countries located in higher latitudes on both sides of the equator. To be successful, however, experience suggests much more is required than just tossing a dart at a map. A site meeting a number of different criteria is required. Requirements of husbandry for the species and species life stage must be met. The physical characteristics of a good site fall within a somewhat narrow range. For the firm to be successful factors involving social, political, regulatory and transportation criteria must be met as well. This article will discuss the physical and biological requirements of siting salmon farms.

Physical Requirements

The physical/environmental characteristics of waters surrounding ice-free coastal Alaska are determined largely by the source, the massive Japanese or Kuroshio Current that moves easterly across the Pacific Ocean, dividing at approximately the border of the State of Washington and the Province of British Columbia. Those waters being the natural habitat of Pacific salmon, they quite satisfactorily meet the requirements of temperature, salinity, and oxygen for salmonids during their juvenile to nearly mature life stages. Waters which emanate from the open ocean appear to be associated with some of the most successful farms. Some important exceptions, however, have been noted in Puget Sound - particularly during the chaetoserous bloom of October/November, 1987. Local conditions that alter the basic physical and chemical parameter of open ocean waters typically do so in an inimical manner, particularly in Alaska. Fortunately most of the waters of Alaska that are adjacent to the Gulf of Alaska may well be suitable for salmon farming. The gulf is, after all, the main rearing area of Pacific salmon of both North American and Asian origin.

Physical/Environmental Influences: The optimum temperature for salmonids (salmon and trout) is 38-60°F; salinity 22-30 ppt; oxygen levels should be above 7 mg/l. Certain

local land forms and characteristics can create localized conditions that fall beyond these ranges, so are to be avoided by the would-be salmon farmer. Areas with extensive freshwater inputs, particularly that of glacial origin; bays, sounds or other relatively enclosed areas with shallow sills barring access routes to deep water; extensive tidal flats; very high current velocities; insufficient water depth; and areas subject to industrial or organic pollution are the main problem spots.

Freshwater influences: Salmonids are referred to as being anadromous. That is, they typically mature, reproduce, incubate their eggs and spend their first days, months or even years in fresh water, and then migrate to salt water for their main growth. Once capable of osmoregulating (physiologically adjusting their blood sodium and chloride ion content) in saltwater (during this life stage salmonids are called "smolts"), they migrate downstream into saltwater. King, coho, and chum salmon and steelhead trout oftentimes spend days or months in areas of intermediate salinity such as estuaries or moving back and forth between oceanic waters and river mouths. Consequently, the upper reaches of narrow arms, with extensive freshwater inputs may be highly satisfactory to the rearing of fry (the free swimming life stage after absorption of the yoke sac and before smoltification), and to smolts and shortly thereafter. Low salinities are thought to assist with the transitional phase incurred during and just after smoltification by assisting with keeping blood salinities normal, between 10 and 12 ppt. Experience indicates, however, that areas of low salinities, <5-10 ppt particularly if salinities change with depth, tides, or weather, can cause problems during the later grow-out phase. Once salmon have adapted to sea water they appear to prefer salt concentrations to remain consistently high. Areas that have wide salinity changes (greater than 5 ppt within a period of less than a day) should be avoided, as should sites with extensive freshwater lenses (>2-4 ft), especially during the summer months.

Glacial waters are often quite cold (<36°F), and highly turbid, which can irritate a fish's delicate gill membranes. Generally, glacial water should be avoided for those reasons. There may be, however, an occasional exception. If a site offers many other advantages and is some distance from the source, or the source is of low volume even during periods of high runoff, and the glacial

water is very shallow (<1-2 ft) and inexpensive power is available, deep water might be upwelled satisfactorily. Some sort of solid material skirt or shroud that encircles the pens and runs from above the water line to below the glacial runoff (which offer other advantages such as keeping floating debris or oil away from the fish) would be helpful. Careful temperature and salinity measurements over the course of a year or more during a variety of weather conditions, however, should be made before a site with glacial influence should be chosen.



Seafoods of Norway salmon farm operating in Port Angeles, Washington, harbor.

Enclosed areas: A satisfactory site should have water that is exchanged often. Bays, sounds, or arms that have a sill or shallow area (depth of less than that found at the pen site) between the site and open water should be avoided. Nutrients from metabolic waste products and uneaten feed can stimulate algae growth in an enclosed area. After the algae dies and sinks, bacteria and fungi consume cell walls and contents. The respiration of the decomposing organisms can deplete oxygen. High winds can then bring the oxygen deficient water to the surface. At best, fish grow poorly and are much more susceptible to disease in low (<5 mg/l) oxygen water. At worst (<2 mg/l) they all die.

The most desirable location for a cabin, float plane or boat moorage may not be the best place for a salmon farm.

Tide Flats: Large tidal flats can cause wide temperature changes. Waters can become too warm (>65°F) in summer and too cold (<38°F) in winter for good growth. Extensive tide flats typically are found near the mouth of

Selecting a Site *continued*

large rivers which carry heavy sediments. The strong fresh water influence can be harmful, as was mentioned previously.

High current velocities: With the high tidal range found in coastal Alaska there are probably no open areas with insufficient current velocities. Norway, for example has a tidal range of about 10 ft. Too high of current speeds are much more likely. At water flows above 5 mph (7 ft per second) it becomes difficult to keep nets from billowing up and forming pockets. Fish do not appear to grow as well or remain healthy in net pens that routinely deform sufficiently to trap them in pockets. While very heavy (1,000 lb) anchors can be used to secure the corners of net pens, much heavier webbing and support ropes must be used to avoid tearing of the net fabric and consequent loss of fish. Anchoring the pen complex becomes much more difficult and consequently expensive in high currents.

Water depth: Adequate water depth assists in spreading wastes and uneaten feed over a large enough area to prevent buildup. Minimum water depth should be 60 ft at the lowest tide on the shallow side of the pen complex - unless special accommodations (such as rearing species that typically use just the upper portion of the water column such as steelhead/rainbow trout) are made. In essence, the deeper the better. An ideal site would have 90 ft or greater depth right next to shore. Stiff legs (rigid attachments between shore and the pens) could then be used to anchor the complex.

Weather Protection: While cages are built that will sustain near-open ocean conditions caring for fish during extended periods of heavy waves is difficult and can be hazardous to operators and workers. Shelter from storm winds and waves is highly desirable. Moderate waves (2-4 ft) can be smoothed by the use of a log boom. Log booms must be properly constructed, however. More damage can be done by a loose log than by the waves that have turned it into a battering ram. Due to the complex manner that storms often move in, picking a site with less than one-half mile of open water in all directions is advisable. Adequate shelter from the prevailing storm winds and waves may require open water distances of less than that.

Biological Requirements

There are several important biological requirements in siting a prospective salmon

farm: The presence or freedom from harmful algae blooms, certain marine plants, predators, and large numbers of other salmonids can spell the difference between success and failure of a farm.

Algae: There are at least two species of phytoplankton that are harmful to salmonids. *Chaetoceros convolutus* is a diatom that has long setae (spikes) with hooks on the ends that can form long chains. They can block and damage gills. The initial response of fish is to feed poorly or not at all. After gill damage occurs troubled fish will be at the surface with their heads pointed up current, next to the netpen edge. Gills become coated with mucus, can have a mottled appearance, and bleed easily. If examined under a microscope the gills appear inflamed as the diatom causes a reaction not unlike that of an insect bite on a human. Dead fish, particularly small ones, often are found with their mouths stretched wide open.

Blooms occur most often in the fall under conditions of little wind and sunny weather, although spring blooms do occur. Water clarity is not a useful guide as even very low concentrations of *Chaetoceros* can cause problems (>5 cells per milliliter). Rainbow trout and Atlantic salmon appear to suffer the worst with neutered coho salmon following. Smaller individuals of the same species may have higher mortalities than do larger ones. This algae is known to occur and to have adversely affected fish in Southeast Alaska and in Prince William Sound.

Heterosigma akashiwo caused extensive mortalities of farmed salmon in certain areas of southern British Columbia during late June of 1986. Thought to occur in heaviest concentrations near the interface of nutrient-laden rivers and salt water, it may produce a mucous-like substance that is toxic to fish. Rainbow trout are the most susceptible species; larger individuals of a given species appear to be troubled more than smaller ones. Its occurrence in Alaska is unknown to the author.

Kelp Beds: Locating a farm near large kelp beds should be avoided. Kelp beds can experience large seasonal die-offs and create huge volumes of drifting materials that can foul nets or in extreme cases cause damage to pens. Herring spawn on kelp also. Eggs can foul nets to the point of blocking water flows.

Predators: Seals and sea lions can wreak havoc with salmon, their natural prey. Farms should have heavy guard nets surrounding pens and placed far enough away so that tidal currents do not cause the nets to touch. Locating a farm near haulouts is to be avoided.

Other salmonids: Large populations of salmon nearby can bring diseases and predators. Consequently, farms should be located some distance away from streams with large spawning populations of salmon.

Other Criteria

This article has been a brief discussion of some of the factors to be considered in siting a salmon farm. There are additional criteria, some rather abstract, to be used before a final choice is made. Social and political considerations of neighbors should not be overlooked. It is quite difficult to argue with the contention that salmon farms change the vista of waterfront property. Proximity to people, goods, services, and transportation figure in importance to costs and chances of success. Lastly, and perhaps the most important, is the site and its location must be suited to the personalities, capabilities, and desires of the operator(s) and his or her staff.

A Cautionary Note: It must be emphasized that selecting an optimum location for salmon farming is, as yet, very much more an art than a science. The vagaries of weather can cause severe problems to salmon farmers. While our pool of knowledge of the cultural requirements of salmon and trout is quite extensive, there is a lack of knowledge about specific weather conditions and the resultant physical and biological oceanographic effects. Cells of low oxygen waters are the principal physical concerns, and the ecology, and distribution of blooms of at least two species of single-celled algae that can cause harm to salmonids are of very high biological importance. It must be emphasized that due to our lack of knowledge about the above mentioned physical and biological oceanographic concerns, even by closely following the guidelines contained in this article and others of a similar nature, success in farming salmon may be elusive. One thing is well known - failure is very expensive.

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Dolly Garza

Dear Reader:

The Marine Advisory Program is pleased to send you the fourth edition of the Alaska Marine Resource Quarterly. We hope you find it full of useful research and technology information as it applies to the fishing industry and other marine resource use groups.

We would like to continue sending this publication at no charge, but this year the Marine Advisory Program has taken some federal and state budget cuts. As a result, we are requesting a subscription of \$8 per year. The fee will cover the cost of printing and mailing.

In these economically troubled times, a new subscription fee is probably the last thing you would like to hear about, but the information you will receive in this publication should far outweigh the cost.

So please send for your subscription right away and make the Alaska Marine Resource Quarterly a part of your resource library.

If you would like to continue receiving our quarterly, please fill out the subscription card accompanying this issue and return it with your payment to: Marine Advisory Program, 2221 E. Northern Lights Blvd., Suite 220, Anchorage, Alaska 99508.

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December 30, 1986

Senator Richard Eliason
P.O. Box V
Juneau, Alaska 99811

Dear Senator Eliason:

The Alaska Mariculture Association (AMA) is looking forward to working with you during the upcoming session to help strengthen Alaska's economy by developing a diverse mariculture industry.

Mariculture, or sea farming, represents one of the most promising opportunities for providing new jobs for Alaskans, but the lack of a clear state policy has resulted in confusing patchwork of often conflicting regulations and statutes. While it is virtually impossible to obtain permits to farm most native stocks of finfish and shellfish, the farming of non-indigenous oysters is allowed.

AMA is working on legislation leading to an easily followed path through state regulatory requirements and essential government services to protect public health and our valuable common property fisheries resources. We will be contacting you in the near future with additional information.

Attached is a report on mariculture developed over the past several months by the Alaska Mariculture Technical Work Group. The work group, which was sponsored by AMA, was composed of representatives of various state and federal agencies. This report presents an unbiased analysis of some issues involved in mariculture development and how they may relate to government programs.

In an effort to keep you informed about the growing interest in mariculture, AMA also is providing you with a complimentary subscription to our monthly newsletter.

We look forward to working with you. Please do not hesitate to contact me for additional information.

Sincerely,

Rodger Painter
Rodger Painter
Executive Director

M A R I C U L T U R E I N A L A S K A

An Examination of Government Programs
by the Alaska Mariculture Technical Work Group
December 1986

December 16, 1986

Mr. Rodger Painter
Alaska Mariculture Association
P.O. Box 020704
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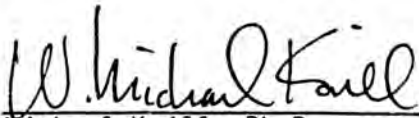
Dear Mr. Painter:

As chairmen of our respective technical subcommittees, we are pleased to present the enclosed documents representing the product of our committee's deliberation on a variety of topics relating to development of a mariculture industry in Alaska.

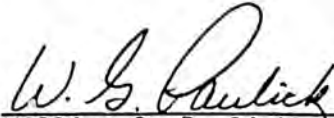
Our purpose is to provide, to the extent possible, an unbiased and accurate analysis of issues relating to a potential mariculture industry in Alaska. We recognize that final decisions must be made by the people of Alaska working through the public process. Because of the complexity and uncertainty of these often new issues, decision makers should find the enclosed documents very useful.

On behalf of the entire technical committee, we would like to thank you for your role in this important effort. We expect that the educational process will continue as Alaska moves forward into this new area of resource development. Hopefully, the information provided here will be of continuing use.

In the interest of public education, we would appreciate the widest possible dissemination of this information.



Michael Kaill, Ph.D.
Alaska Department of Fish & Game
Co-Chair, Siting and
Operations Subcommittee



William G. Paulick
Alaska Department of Commerce
and Economic Development
Co-Chair, Development and
Research Subcommittee

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Reference Materials

Alaska Mariculture Technical Work Group

Broodstock Development--Bill Heard, NMFS

Feed Development & Research Facilities--Ole Mathisen, UAJ

Investment Incentives/Financing--Kellus Sewell, Nordic Alaska

(These discussion papers are available through the Alaska Mariculture Association, P.O. Box 020704, Juneau, AK 99802-0704.)

The Environmental Effects of Floating Mariculture in Puget Sound

Donald P. Weston, School of Oceanography, University of Washington
August 1986

Marine Net Pen Salmon Rearing

Larri Spengler, Alaska Department of Law, Memo, 1/31/85

DNR Tideland Permit for Shellfish Culture

Bob Palmer, Alaska Department of Natural Resources, Memo, 9/19/86

US Forest Service Permitting of Uplands Use for Alaska Oyster Farmers

Michael Barton, U.S. Forest Service Regional Forester, Letter,
7/25/86

A Philosophy for Aquaculture Development in Alaska

Governor Sheffield's Aquaculture Advisory Committee, Memo, 1/20/86

I N T R O D U C T I O N

Mariculture--or sea farming--is the for-profit captive culture of shellfish, finfish and sea vegetables in the marine environment. This is distinct from Alaska's existing salmon ranching program which involves the release of juvenile fish into the ocean to intermingle with wild stocks. The latter also is non-profit and returning fish are a common property resource.

Food products from sea culturing operations are becoming increasingly important throughout the world as seafood consumption climbs and wild fisheries landings remain relatively static. The world aquaculture production (fresh water and marine culture) was estimated at 22 billion pounds in 1983, and is expected to reach 48 billion pounds by the turn of the century.

The productive, unpolluted waters of Alaska's many sheltered bays and fjords are considered ideal for mariculture operations.

The first mariculture operations in Alaska involved the experimental culturing of oysters near Ketchikan in the early 1900s. Several oyster and mussel farms are now in operation and other farms are underway or are under consideration in Southeast, Southcentral and Southwest Alaska.

The State of Alaska recently began a joint project with Japan to test the feasibility of growing scallops in Kodiak and giant kelp (Macrocystis) in Sitka. The National Marine Fisheries Service also is cooperating with the state in an experimental research station in Southeast dealing with problems related to salmon farming.

A general need for policy and issue clarification was recognized by state and federal agencies, potential fish farmers and industry. The Alaska Mariculture Technical Work Group was formed at the invitation of the Alaska Mariculture Association. This cooperative effort represented here could assist in meeting the need for an information base to be used by policy makers.

Legal Status--The legal status of mariculture in Alaska is unclear. While there is recognition of sea farming in statutes, clear regulatory processes are not available to guide individuals wishing to engage in many mariculture activities.

The Department of Law has said that technically the only species for which an applicant can presently receive a fish farming permit is oysters, a non-indigenous shellfish. However, there are mechanisms that allow individuals to harvest some undersized species and hold the animals in a farming environment until they reach salable size.

Specific regulations must be passed by the Board of Fisheries and Department of Fish and Game before sea farmers can obtain permits to collect and hold most native species of shellfish and finfish. Current statutes do not allow state or nonprofit salmon hatcheries to sell or transfer surplus eggs to private farmers.

Siting--The environmental impacts of mariculture operations are site- and species-specific. When siting mariculture facilities, it is important to consider the water circulation in the area and flushing action in the immediate vicinity. Concerns that water quality would be degraded beyond the immediate vicinity of mariculture operations are generally unwarranted. Such conditions would exist only in areas of extremely limited flushing or if culture density was very great.

Mariculture is one of many potential uses of Alaska's tidelands and adjacent uplands. The current decision-making process for these land use decisions involves weighing mariculture against a host of other potential uses.

Permitting--Mariculture is likely to become a significant use of Alaska's tidelands and adjacent uplands. This has prompted the Department of Natural Resources to work on a new tideland permitting process for shellfish operations that would require permittees to meet certain benchmarks to ensure project viability. The new permitting process also provides the mariculture developer greater security than the present system.

Disease and Genetics--Alaska's existing disease and genetics policies appear to provide adequate safeguards for the protection of native and cultured stocks. Endemic disease agents are ubiquitous in wild stocks and the marine environment. Many are opportunistic, causing disease in fish primarily when they are crowded or stressed. Although it is possible for such disease to be transmitted from cultured to wild stocks, catastrophic mortalities from indigenous pathogens would not be expected because of the lack of stress factors in the receiving populations and the wide environmental dispersion of host animals. Mariculture would produce no further risk to wild stocks than the current salmon ranching program provided state disease and genetic policies are followed.

Public Health--Growth of a mariculture industry presents no special public health concerns as existing state regulatory programs governing sanitary practices and seafood product wholesomeness appear to be adequate to provide proper protections.

Brood Stocks--The availability of brood and seed sources will be a major factor in shaping the initial growth of a mariculture industry in Alaska. Orderly development of mariculture would be enhanced by a policy of allowing access to necessary seed and brood sources from wild stocks, but sea farmers should develop captive brood sources for many species over a period of time. Acquisition of brood stocks for salmon and some other fully allocated species may require changes in statutes and regulations. Proper protection of Alaska's wild fisheries resources will require the cautious development of mariculture brood sources. Brood stock programs for captive culture populations should follow appropriate policy guidelines for disease, genetic and exotic species issues.

Research and Development--The success of mariculture throughout the world is largely due to government research in disease prevention and control, broodstock development, and nutritional requirements, including use of local fish meals. The industry is likely to look at government to continue fulfilling these functions.

Training and Education--One of the best methods for the State of Alaska to encourage a strong resident involvement in mariculture is through training, education and extension service programs. Particularly important to local involvement in mariculture operations is the availability of these programs to residents of rural areas. Education and training programs should (1) provide a novice with enough knowledge to allow him or her to start a mariculture business with a reasonable chance of success and (2) train Alaskans to work as technicians at sea farms or hatchery operations.

Taxes--The Department of Revenue was seeking at the time of this report legal clarification of the applicability of the Fisheries Business Tax on cultured seafood. This issue also is important to municipalities, however, since half of the tax is shared with local governments.

Investment Incentives--There appears to be a number of strategies available to the State of Alaska to encourage mariculture development or to influence the composition of the industry. A clear state policy supportive of mariculture is perceived to be a vital factor, while incentives such as credits on the Fisheries Business Tax may influence growth. Resident participation in mariculture could be encouraged through state loans and other non-conventional financing.

Market Development--Although overall consumer demand for high quality seafood is strong and growing, a critical factor to development of a strong mariculture industry is establishment of specific market channels. Early development could help farmers avoid holding products for which there are no markets. It would be helpful to gather market information in an easily accessible format.

Policy and Administration--Selection of a lead state agency has been recommended by a leading mariculture expert, but much more important is development of a strong and clearly articulated state policy regarding mariculture.

I. SITING

A. Species Requirement Criteria

Each species of cultured plant or animal has a unique and specific set of environmental needs. Consideration of the environmental requirements of the species targeted for a sea farm will help assure that the site will be suitable for the proposed operation. Conditions, such as salinity, temperature, flushing action, depth of water at the site and other factors may vary from species to species. For example, oysters are tolerant of salinity changes and exposure to air, while scallops are quite sensitive to those factors.

This procedure could allow for evaluation of permit applications to assure that the site is suitable for the proposed farming operation.

B. Requirements for Aquatic Environmental Protection

Mariculture facilities have several possible environmental impacts on areas adjacent to their location. These effects include changes in water current circulation, an increase in sedimentation and various changes in water quality. These environmental impacts are species- and site-specific, depending on the size of the operation.

When siting mariculture facilities, it is important to consider the water circulation in the area and flushing ability in the immediate vicinity. The placement of mariculture facilities in the water (either rafts with suspended mesh bags or trays for shellfish, or net pens for finfish) will alter the water-current patterns. These structures will decrease water movement which may in turn result in an increase in sedimentation from food particles, feces, and shell debris. The concentration of ammonia-related compounds generated from decomposing organic material may increase, and the amount of dissolved oxygen may decrease. All of these factors may combine to effect the quality of the seafood product being cultured.

Generally, floating facilities have less problems with sedimentation than bottom-culture operations. One way to alleviate a water circulation problem is to place multiple net pens or rafts in a line parallel to the direction of water flow. Proper spacing between nets or rafts should be maintained to allow adequate water circulation. Choosing a site with adequate flushing capabilities will eliminate much of the sedimentation problem. The culture structure should be far enough off of the bottom to allow normal water flow beneath it.

The effects of finfish culture and shellfish culture on water quality of surrounding areas are quite different. Shellfish cultures feed on indigenous phytoplankton and so do not introduce any 'new' nutrients into the area. As much as 40% of the total nutrients can be removed from the water column by these shellfish. Shellfish excrete relatively small amounts of ammonia and related compounds. Finfish cultures may increase the concentrations of ammonia, organic and total nitrogen, phosphate, and total phosphorous and Biological Oxygen Demand (BOD) in the surrounding area. Surrounding concentrations of dissolved oxygen may decrease. Generally, this phenomena is not a problem in culture areas with good water circulation because the metabolic wastes are diluted over a short distance.

The culture of finfish and shellfish results in the release of nutrients and the consumption of dissolved oxygen. A net increase in environmental nutrient levels may be expected in salmonid culture because of nutrient input in the form of feed. Culturing molluscs requires no addition of feed, so no input of "new" nutrients to the marine ecosystem results. However, molluscs do enhance the recycling of nutrients in the water column as they ingest phytoplankton and return a portion of the nutrients to the water column and sediments, making those nutrients available to primary producers again. The filter-feeding activities of the molluscs also serve to concentrate nutrients from a wide area into the area of the sea farm.

Concerns that water quality would be degraded beyond the immediate vicinity of mariculture operations are generally unwarranted. Such conditions would be anticipated only in areas of extremely limited flushing or if culture density was very great. In the few cases where measurable water-quality changes have been noted, the effects have been largely confined within the culture structure.

C. Site-Use Determination

Mariculture is one potential use among many of Alaska's tidelands and the uplands. The current decision-making process for these land-use decisions involve weighing mariculture against a host of other potential uses, including recreation, subsistence, personal use, log transfer sites, commercial fishing, and wilderness, as well as social, political, and economic factors associated with these uses. The most logical procedure to determine site usage is to have potential mariculture locations identified (using a set of predetermined, proven site criteria) and then included in the State Land Use Plans, such as the Prince of Wales Island area and

the Prince William Sound area plan. These plans attempt to balance many disparate and sometimes competing interests. If the potential mariculture sites were included in such a plan, site decisions would be straightforward and timely. While these area plans would be developing mariculture policies within the planning areas, statewide mariculture policies could result from these efforts. Another option is the development of a new plan similar to the ones generated by the Private Nonprofit Hatchery Program, which are presently working quite well. The development of a new plan does not seem currently possible because of the time and resources needed to develop such a plan. The inclusion of potential sites into state plans also seems unlikely due to the present lack of state funding for future plans. Thus, it seems that the present and future basis for the site decision making will be made on a case-by-case basis by all state and federal agencies involved with either permitting or resource review. These decisions will involve, for example, on federal public lands, wilderness capability analyses using the Alaska National Interest Lands Conservation Act (ANILCA) Sections 507(a) and 1315(b and d), and subsistence evaluations using ANILCA Section 810. Subsistence, as defined by ANILCA, provides for the customary and traditional consumptive uses of fish, wildlife, and other wild renewable resources by rural Alaska residents on federal public lands. It does not preclude the use of other resources but requires that an evaluation of effects be made. In Section 804, the nonwasteful subsistence uses of fish and wildlife shall be accorded a priority over the taking of fish and wildlife on public lands for other purposes. Another determination, which may be and probably will be required, is a cumulative effects analysis. This determination will probably be the result of legal actions and the expected large number of mariculture sites. These two determinations, and especially the case-by-case determinations, will necessitate more work by all the agencies involved as well as time delays for the applicants.

II. PERMITTING

A. Statutory/Regulatory Status

The legal status of mariculture in Alaska is unclear. While there is legal recognition of sea farming in statute, clear regulatory processes are not available for applicants to engage in many mariculture activities. Unclear are issues such as the ability of individuals to gather brood stock in limited fisheries, use of gear not authorized in the commercial fishery, and the harvesting of juveniles for culturing in fisheries with size limitations.

The Department of Law has determined that private, for-profit mariculture is covered by existing statutes. However, the department said, the Board of Fisheries and ADF&G must enact specific regulations before sea farmers can obtain permits to hold live fish or shellfish. To date the board has approved the farming of a non-indigenous species--oysters. Current statutes do not allow state or private nonprofit hatcheries to sell surplus salmon eggs to private salmon farmers.

There is no clear regulatory structure supportive of the development of a mariculture industry, although there are mechanisms to allow some activities. For instance, it is legally possible to obtain a permit to commercially harvest some undersized species and to hold the animals in a farming environment until they reach salable size. This method would appear to be most suitable in fisheries where there are no size and sex restrictions and little competition for the resource, such as mussels. There also is provision in law (AS 16.05.050 (11)) under which the Commissioner of ADF&G can authorize interim-use permit holders to engage in the experimental taking of fisheries resources. This statute may be a vehicle to allow the collection of brood stock for farming purposes in some fisheries.

ADF&G and the Department of Commerce and Economic Development are conducting a joint project with Japan to test the feasibility of culturing scallops in Kodiak. Local "cooperators" participating in the experiment have been issued scientific/educational permits for the collection of spat, and will be allowed to hold scallops for experimental purposes. However, the cooperators are not allowed to engage in "commercial" activities such as the sale of spat, juvenile or adult scallops.

B. Agency Coordination

Oyster farmers follow the established permitting path for use of state tidelands, and production and sale of shellfish products. The most critical permitting process is physical aquatic siting. This generally involves the Departments of Natural Resources, Fish and Game, and Environmental Conservation, the Army Corps of Engineers, and the Environmental Protection Agency. Permits for uplands usage at individual sites may require the additional involvement of the U.S. Forest Service, U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, or other federal agencies.

Coordination of state and federal agency responses to the physical siting process is handled by the Division of Governmental Coordination (DGC) in the Office of Management and Budget. The DGC's review process is designed to

coordinate federal, state, and local review of projects in the coastal areas of the state. It is oriented to address any land management or resource regulatory issue related to physical siting and design of proposed projects. A key component of the process is review of the "consistency" of the proposed project with the standards of the Alaska Coastal Management Plan. Mariculture projects will be reviewed for their consistency with recreation, subsistence, habitat, and with air, land, and water quality standards. Applications for mariculture projects are reviewed on a 50-day schedule, which means the DGC will complete its review within 50 days unless non-consistency or other problems are raised.

New permitting systems required for mariculture development should fit within the existing DGC review process and timetable.

C. Project Development

Based on the growing interest in sea farming, mariculture is likely to become a significant use of Alaska's tidelands and adjacent uplands. As such, land managers and upland owners are interested in ensuring that sites are utilized for permitted activities and do not result in speculation. At the same time, these land managers have interest in developing a system that responds to the needs of the individual grower and results in a strong, diverse mariculture industry. ADNR currently is working on a new tidelands permitting process for shellfish operations that would require permittees to meet certain benchmarks to ensure project viability, while providing greater security for the mariculture developer than the present permitting system.

The characteristics and the scope of a mariculture project will be determined during the permit process. The applicant's development plan will become a part of the permits and they will describe: (1) what species will be raised; (2) size and location of the project; (3) type of structures used for growing; (4) whether upland support facilities will be allowed; (5) environmental safeguards that will be implemented; and (6) a timetable that will be used to monitor the progress during construction and development.

During the early stages of development, ADNR will be using these permits and develop a plan to monitor the progress of a project. ADNR will be emphasizing the need to use the land for its intended purpose within a specified period of time. The intent of this monitoring is to ensure the land speculation is not occurring and that approved sites are available to create a land base large enough to support a self-sustaining industry.

As the project gets into the production phase, the monitoring by ADNR will become less important and the roles of ADF&G and ADEC will become more important in regulating water quality, protecting public health, and certifying brood sources.

To ensure mariculture develops into a self-sustaining industry, ADNR is considering modification of land-use permits and leases to meet the need of a grower. At the present time, there is no guarantee for the grower that starts out with a land-use permit and then requests a lease with a term of more than ten years. The site will be put up for bid at a public auction and the grower may lose the site if he is outbid. A lease term of less than ten years may be negotiated if the director finds it in the best interest of the state.

III. FIN/SHELLFISH HEALTH AND GENETICS

A. Fin/Shellfish Health

1. Importation of exotic diseases

Current regulations (5AAC 41.070) prohibit importation of exotic finfish or shellfish species into Alaska except Pacific Northwest-cultured, Japanese oysters and ornamental fish for non-release only. Oysters can be imported only after disease certification by the ADF&G, Division of Fisheries Rehabilitation, Enhancement and Development's Fish Pathology Section and only after the importing party obtains a Fish Transport Permit (5AAC 41.005), which must also be evaluated by the Fish Pathology Section. Adequate control to prevent importation of exotic diseases is in effect.

2. Potential dissemination of indigenous aquatic animal diseases within the State of Alaska by movement of mariculture species

Possession or transport of any live fish or gametes thereof requires a Fish Transport Permit, as above, the application of which is evaluated regarding various concerns, including finfish or shellfish disease within the stock or brood source on which the permit is approved or denied (5AAC 41.020; 41.030). The definition of a fish includes all invertebrates and amphibians (AS 16.05.940). In addition, disease control is required at hatchery or rearing facilities (5AAC 41.080) through disinfection procedures and yearly hatchery inspections by a qualified fish pathologist. Disease outbreaks must be reported to the Fish Pathology Section which is governed by these

regulations in recommending to the Commissioner the disposition of said diseased fish. Current regulations appear adequate to control movement of finfish and shellfish diseases affecting mariculture practices.

3. Transmission of diseases from cultured finfish or shellfish species to wild stocks

Future mariculture practices would produce no further risk to wild stocks than practices currently employed. Certain disease agents are already ubiquitous in the environment and opportunistic, infecting fish only when they are crowded or stressed artificially by aquaculture practices. Other disease agents which are obligate pathogens could possibly transmit from cultured finfish/shellfish to wild stocks. Although this would be undesirable, most generally clinical disease or catastrophic mortalities do not result in the receiving wild populations due to the lack of stress factors and wide environmental dispersion of host animals.

Although some risk is present now and will be present in future mariculture endeavors, there are adequate, current regulations cited previously for monitoring cultured fish/shellfish stocks for disease, and control of such diseases to protect both wild and other cultured stocks.

4. Environmental contamination by therapeutic drugs or chemicals used in mariculture practices

There are no data on which to evaluate this possibility. However, certain premises suggest that this is an unlikely concern: (1) The great magnitude of dilution of such drugs in the water column would make the final exposure concentration so far below efficacious levels that natural fauna and flora should be unaffected; (2) the infrequency of use would prevent chronic exposure of natural flora; (3) in most instances, a systemic chemotherapeutant is the only practical method to treat a disease affecting thousands of captive fish. Consequently, the drug is administered in the diet and metabolized with very little of the medicated feed left to allow leaching of the drug into ambient water.

Circumstantial information suggests that drugs used in mariculture operations present a negligible risk to the environment.

5. The increasing demand on state pathology laboratories to conduct disease surveillance for private enterprise

will incur additional costs that must be borne by the state in order to maintain control of disease occurrence within cultured and wild stocks of finfish and shellfish.

B. Genetics

ADF&G has a detailed policy statement developed dealing with the issue of genetics, including transportation of stocks and importation of non-indigenous species. Exceptions to this genetics policy will be made on a case-by-case basis. While it appears that there is considerable opportunity for genetic engineering as part of mariculture activities, that field is largely unknown.

IV. PUBLIC HEALTH

The Alaska Department of Environmental Conservation (ADEC) is responsible for ensuring sanitary control and product wholesomeness of all phases of the seafood industry. This responsibility is addressed in 18 AAC 34, the Fish Inspection Regulations.

With regard to the shellfish industry, ADEC certifies all shellfish waters for harvesting on the basis of sanitary quality and public health safety, regulates the harvesting of shellfish, makes laboratory examinations of shellfish and shellfish waters, and restricts the harvesting of shellfish from particular areas in public health emergencies.

Processing of other mariculture products also would be dealt with through existing ADEC regulations to protect the sanitary quality and public health safety of the particular mariculture product.

A. Water Quality

Water quality of a shellfish growing area must meet minimum standards established by the federal Food and Drug Administration, "National Shellfish Sanitation Program (NSSP)." Prior to harvesting a shellfish growing area, ADEC conducts a sanitary and biological survey of the area before approving it to allow shellfish harvesting for sale for human consumption.

The examination is verified by laboratory findings when needed to indicate that pathogenic microorganisms, radionuclides, pesticide chemicals, harmful industrial wastes, and sewage wastes do not reach the area in dangerous concentrations and do not pollute the shellfish in the area.

Laboratory water samples from the sanitary survey are analyzed by the ADEC Palmer Laboratory to ensure that the samples do not exceed standards established by the NSSP.

Factors which may affect water quality are location of nearby pollutant sources, other users of the growing site, vessel traffic, freshwater streams, float houses, human habitation, and point source pollution.

The use of nets treated with tri-n-butyl tin (TBT) has been extensive in Norway and other countries involved in sea farming. This compound is used as an antifoulant to reduce labor costs associated with cleaning nets. Public health concerns have been raised over the use of TBT, a heavy metal.

However, the use of TBT in connection with mariculture in Alaska is not likely to be a problem since the ADEC presently is not approving permit applications for aquaculture operations using TBT-treated nets.

For information on requirements of the "National Shellfish Sanitation Program", refer to the program's Manual of Operations, Part 1. Sanitation of Shellfish Growing Areas, U.S. Department of Health and Human Services, Food and Drug Administration, 1986 Revision.

B. Food Quality of Mariculture Products

ADEC is responsible for ensuring that all seafood products intended for human consumption are wholesome and uncontaminated.

Shellfish (clams, mussels, and oysters) possess the ability to filter and concentrate pathogenic microorganisms and toxic substances from the water. Furthermore, shellfish are packed whole and alive and are often consumed raw or lightly cooked. For these reasons, the public health significance of consuming shellfish for food is very important.

Other mariculture products intended for sale for human consumption would need to be evaluated and protected from potential contamination or adulteration that could result from pathogenic microorganisms and toxic substances.

1. Paralytic shellfish poisoning

Paralytic shellfish poisoning, or "PSP", is a very serious illness caused by poisons concentrated in some varieties of dinoflagellates, a kind of microorganism. Since shellfish feed on these organisms, they can absorb and store the PSP toxin. The presence of PSP in Alaska has been well documented, and shellfish intended for commercial markets must be quarantined and tested for the toxin before being released for sale for human consumption.

Currently, testing for PSP is done through the ADEC laboratory in Palmer. The only test currently certified by the Food and Drug Administration is a mouse bioassay. Research is ongoing at several universities to establish other testing methods for PSP, but none have been certified to date.

2. Coliform testing

The National Shellfish Sanitation Program has minimum coliform standards for shellfish meat that must be met before shellfish can be commercially marketed. The need for actual coliform testing of the meat is determined by an ADEC review of the sanitary survey to see if actual or potential pollution may be present.

3. Sanitation

Harvesting and processing areas must meet state and federal regulations currently in existence to guarantee proper sanitation and product wholesomeness. This includes, for example, separation of raw and finished product, transporting under refrigeration, and holding shellfish during PSP and/or bacterial testing.

V. BROOD STOCKS

Development of dependable, high quality brood stock sources in sufficient quantity to meet initial and long-term needs will be a critical step in providing a strong foundation for mariculture. During the initial phases of growth, general availability of brood and seed sources will likely be a major factor in deciding which species are developed and where development occurs.

Proper protection of Alaska's wild fisheries resources will require the cautious development of mariculture brood sources. Brood stock programs for captive culture for profit populations should follow specific policy guidelines for disease, genetic, indigenous and non-indigenous species issues.

Orderly development of mariculture would be enhanced by adoption of a policy by the State of Alaska to assist in initial access to necessary seed and brood sources from appropriate wild stocks. Over the long term, however, sea farmers should develop captive brood sources for many species. This will be particularly important in brood sources secured from fully allocated common property resources.

Acquisition of brood stocks and seeds also may require changes in statutes and regulations. For instance, the sale of surplus eggs from existing hatcheries to private farmers appears to be prohibited by state law. Legal issues also are raised by the capture of under-sized juveniles, use of gear not authorized in the commercial fishery, captures when the commercial fishery is closed and ability to capture wild brood sources in limited fisheries.

A. Salmon

Most interest in salmon farming in Alaska revolves around chinook and coho stocks. Alaska now has well developed public and private hatchery programs releasing large numbers of smolts of these species. Many of these programs achieve large enough returns to satisfy brood needs, provide catches to common property fisheries and allow terminal area cost recovery harvests. Present performance and estimates of survival rates and other factors suggest that these hatchery programs could provide large enough surpluses of chinook and coho eggs to satisfy the initial needs of a salmon farming industry in Alaska.

The food quality of returning hatchery salmon deteriorates rapidly, and many fish harvested in terminal areas for cost recovery would be more valuable as egg sources for salmon farming. A higher value for cost recovery catches could mean more fish are made available to the common property fisheries. It is estimated that 10 to 20 million surplus chinook and coho eggs per year could be made available for farming purposes under a strategy of allowing cost recovery

egg sales. Statutes would have to be amended to allow surplus egg sales from private or public hatcheries for salmon farming.

B. Trout, Char, Steelhead

There are no current brood stock surpluses in Alaska's hatchery programs for these species. Farming brood stock development for these species probably would be modeled after the conservative, carefully controlled egg take schedules from wild stocks taken already for our existing salmon ranching programs. These salmon egg takes are conducted on the healthiest wild stocks on varied schedules to ensure protection to the donor populations.

C. Non-indigenous Salmonids

Atlantic salmon is the most intensely farmed salmonid in the world. Some British Columbia and Washington State farms are now growing Atlantic salmon, partially because of limited sources of Pacific salmon brood stocks. The State of Alaska's disease and genetics policies and regulations currently prohibit the importation of live salmon or eggs.

D. Black Cod

Present interest in black cod (sablefish) farming is based upon the concept of capturing early life-stage juveniles from wild populations, and growing the fish to marketable size. Farming of black cod is being conducted on an experimental basis in British Columbia. High market prices have created strong competition for Alaska's black cod, and the state's only in-shore fishery already has been limited. Knowledge of this species is somewhat limited, suggesting that black cod farming should proceed cautiously.

E. Oysters

Several oyster farms are presently operating in Southeast with seed spat being imported primarily from Washington. Logistical problems in importing this spat have resulted in significant losses to many operators and remain a primary concern of existing farmers. While it may be necessary to develop an oyster seed hatchery in Alaska to ensure continuous dependable supplies, present sources of spat appear adequate to meet foreseeable demand.

F. Mussels

Mussel farming is based upon the collection of wild spat. In this case, Alaska has an abundant, widely distributed and unutilized resource, and there does not appear to be any biological need for constraints upon collection of wild spat.

G. Scallops

Interest in scallop farming has grown rapidly, particularly in the Kodiak area where a feasibility study is being conducted on collection of weathervane scallop spat using Japanese techniques. The distribution of natural populations is limited, but scallops produce enormous quantities of gametes and continuous collection of wild spat for farming probably won't pose biological or allocation problems.

H. Abalone

Abalone farming in Alaska probably would follow the development of culturing programs in Japan and California where hatcheries are used to produce spat for brood purposes. Competition is strong for Alaska's relatively small abalone resource open to commercial harvest.

VI. RESEARCH AND DEVELOPMENT

The success of mariculture is largely due to progress in three areas: (1) controlled breeding of domesticated broodstock; (2) understanding of the nutritional requirements of cultured organisms; and (3) control and prevention of disease. All three elements are involved in development of any mariculture operation, including shellfish, finfish and sea vegetables. Even if mariculture development is industry-driven in Alaska, there's a major role for government to play in research and development.

A. Broodstock Development

The biggest initial problem facing shellfish farmers in Alaska is location of dependable sources of spat. Indeed, the collection of spat is a major concern of established shellfish farming industries throughout the world. For the short term, the farming of indigeneous shellfish probably will rely upon the capture of wild spat or juvenile animals. Hatchery production of shellfish spat is an option for development of dependable sources for farming operations, but technical obstacles must first be overcome for some species.

The Norwegian success in salmon farming can be partially linked to the establishment of an experimental government genetics laboratory. A variety of salmon stocks were tested for growth characteristics, food conversion, fecundity, disease resistance, maturity schedules and other desired characteristics. The few stocks selected form the basis of an ongoing selection program. The University of British Columbia is undertaking a similar broodstock development program for Canadian farmers using coho hatchery stocks.

Development of salmon farming in Alaska would pose similar needs involving chinook and coho. Broodstock development using hatchery stocks would help guide farmers to the most suitable brood stock sources. Selection of the right broodstock could be critical to the success of fish farming.

B. Fish Nutrition and Dietary Requirements

Since about 60 percent of the production cost of farmed fish is procurement of food and feeding, a successful fish farming industry creates a demand for local production of food. An important research need is experimental work to develop the proper diet for Alaska conditions using ingredients that can be procured locally. While there is substantial agreement to the ratio of fish meal, dry ingredients and the fresh fish components of a diet, it is desirable to utilize stocks of local fish which aren't currently harvested in a commercial fishery. This would create new fishing opportunities and provide raw product to feed mills at low cost. Some waste products from processing plants also can be utilized in fish food.

C. Experimental Facility

A variety of fisheries research programs exist in Alaska, but no single agency has the resources to undertake the research outlined in this document. One potential solution is a coordinated approach to mariculture research involving a number of state and federal programs, resulting in a pooling of talent and financial resources under a single program. An important potential source of operating funds for such an experimental facility could be proprietary research for individuals and companies.

D. Database

Orderly development of a mariculture industry will be assisted by the gathering and organization of solid statistical data on the growth and performance of the industry. This database will be particularly helpful in market development and the growth of in-state support industries. The state could incorporate reporting requirements for quantities of brood or seed, production and product on hand into licensing programs.

VII. TRAINING AND EDUCATION

One of the best methods available to the State of Alaska to encourage a strong resident involvement in mariculture is through education, training and extension service programs. A special effort should be undertaken to make these programs available to residents of coastal communities to ensure local involvement.

Education and training programs should focus on two separate objectives: (1) provide a novice with enough knowledge to allow him or her to embark upon a mariculture business with a reasonable chance of success; and (2) train Alaskans to work as technicians at sea farms or hatchery operations.

A. Components of a Comprehensive Program

The most effective program would provide education and training at all levels: high school, post-secondary, vocational and extension services. High school technical training will serve to inform young Alaskans about jobs and career opportunities in mariculture. Post-secondary mariculture education helps ensure a resident pool of expertise, while vocational-technical courses provide focused education aimed at providing local residents with operational job skills needed by the industry. Extension services are particularly important to residents desiring to develop small scale mariculture operations and support services.

B. Coordination

Components of this comprehensive program are likely to be located throughout Alaska's diverse educational system, including local school districts, University of Alaska, Marine Advisory Program, community colleges, private institutions (Sheldon Jackson College), vocational education programs, and services offered by various governmental agencies (Office of Commercial Fisheries Development, FRED Division). Coordination of these programs could help avoid duplications and identify gaps in programs.

C. Training Areas

Education and training should cover the spectrum of planning, operational and regulatory concerns, including but not limited to physical operations, biological operations, economics, regulatory programs and technology.

1. Physical operations--site selection, physical plant design, equipment, utilities, support services, chemicals, transportation, processing, product quality
2. Biological operations--brood stock acquisition and development, disease management, nutrition, environmental quality
3. Economics--business management, operational costs, supply and demand, marketing, cash flow, financing, short- and long-term financial and operational planning
4. Regulatory--explanation of the regulatory process involving training and applicant manuals, helpful agencies and nonprofit organizations

5. Technology--dispersal of information regarding technological advances in equipment, nutrition, disease and other operational concerns

VIII. TAXES

Development of a clear and stable taxing policy is an important ingredient of governmental response to a developing industry such as mariculture. While municipal taxing authority over locally raised mariculture products appears clear, the applicability of existing food taxes levied by the state is uncertain. Clarification of this issue will be important to the state, local governments and prospective farmers alike.

A. Fisheries Business Tax

The Fisheries Business Tax currently imposed on commercially processed or exported seafoods ranges from one to six per cent of the product value at its first point of sale or export. Except for limited circumstances, the tax is based upon the amount paid a harvester by a processing company or broker. If mariculture products were to be taxed under the current structure, most mariculture farmers would be taxed at three per cent of the export product value. In-state sales of fresh product probably would not be taxed.

After studying the statutes and regulations, the Department of Revenue decided it should seek a legal advice from the Department of Law concerning the applicability of the Fisheries Business Tax on mariculture products. The Department is uncertain whether the tax was designed as a severance or product tax. Since state law provides municipalities with 50 percent of the collections of the Fisheries Business Tax within their jurisdiction, the issue is important to local governments.

B. Local Taxing Authority

Recent revisions to Title 29 broadened the taxing authority of local governments. All municipalities appear to have the authority to impose local sales taxes on seafood products purchased or sold within their taxing jurisdictions. Several local governments currently levy such taxes ranging from one to three percent of the initial purchase value.

C. Seafood Marketing Assessment

The Alaska Seafood Marketing Institute is partially funded through the Seafood Marketing Assessment which is a tax applied to processing operations and round fish exports or in limited cases to seafood brokers or distributors. This tax currently is fixed at .2 percent of the initial purchase

or export value. It appears to be applicable to mariculture products.

IX. INVESTMENT INCENTIVES

There appear to be a number of strategies available to the State of Alaska to encourage mariculture investments or influence the composition of the industry. In crafting these strategies, social and economic objectives should be carefully weighed. For instance, local employment and resident ownership may be achieved through divergent policies, and economic stability may come through involvement of a blend of corporate and family farming operations.

Large corporations or companies desiring to develop mariculture operations generally have access to venture capital through existing collateral bases or established relationships with financial institutions. These investors also can afford to hire experienced professionals to craft a financial prospectus, deal with difficult regulatory processes or manage a farm. Individual Alaskans interested in small to moderate farms generally lack the collateral base, trust of financial institutions and operational experience. These competitive disadvantages can be partially offset through non-conventional financing and other incentives designed to encourage resident investment.

Important to note is that other countries with developed mariculture industries have used combinations of incentives and regulatory devices to achieve socio-economic goals. Examples can be found in Norway where the government has restricted production size of salmon farms and extended licensing preference to local residents to encourage small operations in rural locations. These policies are directed at reversing population migrations to urban areas. The Japanese government has actively encouraged the development of cooperative farms involving local residents of fishing communities who often combine fishing and farming activities.

Regulatory/Political Climate

A clear policy supporting and encouraging mariculture development throughout the state's regulatory structure is perceived to be extremely vital to the growth of sea farming. A strong governmental policy supporting salmon farming has been critical to the rapid development of pen-rearing operations in British Columbia. This also has been true in Hawaii, Japan and Norway. Conversely, the growth of salmon farming in Washington State has been hampered by confusing and conflicting policies between various state agencies and county governments.

B. Taxes

A major attraction to venture capital in the British Columbia salmon farming industry has been a government program allowing tax-free profits up to \$500,000 (Canadian currency) from qualified farming investments. This policy helped attract millions of dollars in investment capital. This avenue would be open to the State of Alaska through amendments to its corporate tax laws.

If the Fisheries Business Tax is applied to mariculture products, another potential incentive available to the state would be tax credits or a temporary moratorium on Fisheries Business Taxes on new facilities. A model for a tax credit program could be found in legislation approved by the 1986 Legislature. The legislation (House Bill 58) was designed to encourage the building of new shore-based processing facilities, expansion of existing plants, diversification of product lines, and improvement of product quality. This incentive also could be accomplished by a moratorium on the Fisheries Business Tax during the first years of production of a new farming operation.

C. Non-conventional Financing

The state could encourage resident involvement in mariculture through establishment of a state loan program or loan guarantee fund. These non-conventional financing arrangements could be geared toward small to medium sized projects to qualified Alaskans. This program could potentially be targeted to assist residents of economically depressed rural communities. Non-conventional financing could be particularly important to family-sized mariculture operations.

Another option could be to focus on amendments to national agricultural loan funds to include financing for small-scale mariculture projects.

D. Non-cash Incentives

Another method to entice investment capital is through long term tideland leases, water rights and lease or grants of state-owned uplands for staging facilities. These non-cash incentives and tax advantages could be offered to firms which meet certain state objectives, such as employment of residents from areas of high unemployment or with commercial fishing backgrounds, or providing equity participation by Alaskans.

X. MARKET DEVELOPMENT

Although overall consumer demand for high quality seafood is

strong and growing, a critical factor to development of a strong, diversified mariculture industry is establishment of specific market channels. This market development ideally occurs before farms reach the production stage, so farmers don't end up with products at the marketing stage that cannot be sold. Failure rates in mariculture can be affected by the early establishment of market development programs.

A. Market Information

A large body of knowledge exists concerning seafood quality and marketing of Alaska products. While most is directed at products of wild origin, much of the information also will be applicable to cultured seafood. The information has not been gathered in an easily accessible format that could benefit prospective sellers of cultured--or wild--seafood products. Consequently, each interested individual must invest significant amounts of time and energy into essentially duplicative research.

B. Market Research

A good market research program would focus on development of specific market-related information on target species prior to commercial production. Critical market problems and opportunities should be identified for each species on a priority basis.

C. Alternative Markets

Cultured seafood products may not follow existing marketing channels, forcing farmers to focus on development of specialty or select markets. In analogous situations this need has led to the creation of private marketing entities conducting common promotion and assuming direct involvement in the sales process.

D. Quality

A primary benefit of cultured seafood is the relative ease of providing consistently high quality products. The early development of minimum and target quality standards for each product would benefit pioneering farmers and prevent problems as the industry grows and operational patterns are developed.

E. Transportation

The cost of moving product to market will play a significant role in siting of farms and market price of the finished product. Concentration of Alaska's mariculture activities or development of innovative transportation systems will help allow economies of scale in shipping and make Alaska cultured seafood price competitive.

F. Generic Promotion

The Alaska Seafood Marketing Institute's programs are designed to promote the benefits of all Alaska seafood products and do not make such distinctions as "troll-caught" or "net-caught," and "wild" or "cultured." However, some differentiations are possible under ASMI's enabling statutes but must not create competitive advantages for specific companies or regions of the state. ASMI promotions are determined by its industry board of directors which generally allocates the promotional budget in proportion to the value of Alaska's seafood production sold in U.S. markets. These amounts are adjusted to reflect market conditions and other factors.

XI. POLICY AND ADMINISTRATION

As outlined in this report, government will play a major role in the development of Alaska mariculture industry. The specific roles of various agencies in that process will be determined through consultation from the governor and legislature. One key policy decision will be the determination of how various agencies involved should interact, and whether a lead agency for mariculture should be designated. In determining the appropriate governmental structure, it might be useful to view the primary functions of agencies in terms of development advocacy and regulatory functions.

A. Lead Agency

A leading U.S. aquaculture law specialist brought to Alaska in early 1986 to discuss mariculture development strongly recommended the designation of a lead agency. The lead agency should be a development advocate with the ability to pull together state, local, federal and private resources to ensure success. The goal for this lead agency would be to streamline the permitting process and strengthen advocacy programs, while the objective would be to put Alaskans to work and create new wealth with the sale of a finished product.

While this concept is sound, the present structure of state agencies do not easily facilitate a lead agency with both advocacy and regulatory functions. The Department of Commerce and Economic Development has a strong advocacy program, but lacks regulatory jurisdiction and staffing. This also is the case with the Department of Community and Regional Affairs. At the same time, the resource agencies (DNR, ADEC and ADF&G) and the Division of Governmental Coordination in the Office of Management and Budget have strong regulatory and permitting functions but lack economic development staffs.

The present structure of state government might be more easily adapted to a cooperative approach with lead advocacy and permitting agencies. This concept would have prospective farmers making initial contacts at the lead advocacy agency which would in turn provide permitting road maps directing applicants to the proper lead permitting agency.

B. Policy Development

Regardless of which agency is considered lead, the parade should be led by a strong, clearly articulated state policy regarding mariculture development. This policy should give clear guidance to the agencies for making such value judgments as:

- (1) The balance between creation of jobs and the maximum amount of industrial capital.
- (2) Balance of environmental protection and economic development.
- (3) The importance of mariculture as a use of state tidelands and uplands.
- (4) Role of mariculture in efforts to diversify Alaska's economy.
- (5) Weight of specific social objectives (local employment, Alaska equity, tax revenues, etc.).
- (6) Recovery of private wealth created from common property resources.

Alaska Mariculture Report

Published by the
Alaska Mariculture Association

December 1986

Vol. 1, Number 2

The Alaska Mariculture Report is published monthly by the Alaska Mariculture Association (AMA). The newsletter is designed to provide information relating to mariculture development in Alaska, as well as to report on AMA activities. We encourage readers to submit articles for publication or suggest newsletter items. Write: Alaska Mariculture Association, P.O. Box 020704, Juneau, AK 99802-0704.

AMA Asks Policymakers to Promote Mariculture

The Alaska Mariculture Association (AMA) has called upon state policy-makers to adopt legislation promoting mariculture.

AMA issued the request following a recent meeting of its board of directors in Juneau. AMA concluded that the introduction of legislation is the best way to clarify ambiguous statutes and regulations and clearly articulate a policy on sea farming.

"The growing consumer interest in seafood has combined with a static level of commercial harvests to produce a very positive market climate for cultured seafood," said Paul Fuhs, AMA president. "We believe Alaska may miss these favorable market conditions if it fails to enact a clear state policy on mariculture. This emerging industry is becoming ensnared in red tape, and we're asking the governor and legislature to help us get free."

Research by the Department of Law indicates the only commercial form of mariculture specifically sanctioned under current law and regulations is oyster farming--a non-indigenous species. Meanwhile, the farming of native stocks, such as scallops and mussels, have no established permitting process except for scientific or educational projects.

"Our examination of the legal status of mariculture has revealed a confusing patchwork of often conflicting laws and regulations that results in barriers to applicants," Fuhs said. "While present state law recognizes the legal status of mariculture, there are legal and regulatory uncertainties stifling investments."

"One enterprising Alaskan has found a route around these roadblocks by obtaining a permit to commercially harvest wild juvenile mussels and growing them in captivity to a marketable size. But this path has been torturously difficult, requiring a tremendous investment in time and energy by an individual who is familiar enough the permitting process to find what may be best characterized as a loophole."

The shortcomings of the current legal situation are very apparent to aspiring scallop farmers in Kodiak who are participating in an experimental project sponsored jointly by the State of Alaska and Japan. These "cooperators" have been issued special science/educational permits to gather and hold wild scallop spat.

Several of these "cooperators" are expressing interest in proceeding with some independent commercial applications. However, the "sci/ed" permits are very restrictive and the state has had to caution the individuals to refrain from any commercial activities.

"The Department of Fish and Game has responded to these requests and is working on a permit to allow the commercial gathering of wild scallop spat," Fuhs said. "How we get from the hunting and gathering phase to actual cultivation isn't clear, however, as the proposed permits won't authorize the growing or farming of the scallops."

"We're calling upon Governor Cowper and legislators to develop a clear state policy on mariculture that will promote the industry and result in a simplified, straight-forward permitting process," Fuhs said. "Mariculture offers the promise of adding thousands of year-round jobs in Alaska's coastal communities and creating many economic spinoffs in service centers and transportation hubs such as Anchorage."

Study Finds Small Environmental Risk from Mariculture

A scientific study conducted for the University of Washington has found that mariculture poses no clear environmental risks when located in areas with adequate water circulation.

The UW study assesses "the probable magnitude of environmental changes that may result from mariculture operations in Puget Sound" and discusses the range of environmental issues raised by shellfish and salmon farming. Following are excerpts from the report:

Water Circulation--"A culture structure placed in the marine environment will reduce current velocity in the surrounding area, particularly in the downcurrent direction. However, this effect is not likely to be significant except in cases of intensive culturing in an area with very restricted natural circulation."

Water Quality--"Field studies have typically observed little or no changes in water quality outside the culture structure in well-flushed areas. Adverse effects would be anticipated only in

areas of extremely limited flushing or very intensive culturing activity."

Phytoplankton--"Floating mariculture is unlikely to have a measurable effect on phytoplankton standing stock or productivity in most of Puget Sound. A localized and measurable effect on productivity would be expected only in highly stratified and poorly flushed areas in which the water passing through a culture structure could maintain its integrity with minimal dilution."

Sedimentation--"Floating mariculture generates large amounts of solid wastes in the form of feces and unutilized feed (salmon culture) or feces, pseudofeces and shell debris (shellfish culture)...While there are profound effects on sediment chemistry, and consequently the sediment biota, these effects are very localized. Visible accumulation of solids and alteration of sediment chemistry typically extends no more than 30 meters from the culture structure...The depth of this accumulation depends for the most part upon water depth and current velocity."

Fish and Megafauna--"Accumulation of organic material in the vicinity of a mariculture operation may result in the loss of nonmotile megafauna (e.g. geoducks) living in intimate contact with the sediments. However, fish and motile megafauna (e.g. crabs) living on or above the sediment surface are typically found in higher densities around floating mariculture structures than in the surrounding area."

Introduction of Exotic Species--"If culture operations require the importation of live material into the state, the potential introduction of exotic species probably represents the greatest environmental threat posed by mariculture. Introduced species may establish self-sustaining wild populations, potentially becoming pests or eliminating native species. While there appears to be little risk of this occurring for those species currently being deliberately introduced for culture in Puget Sound, requests for future introductions should be carefully evaluated in this regard."

Diseases--"There is a fear that the disease organism may proliferate among the cultured fish, become more virulent, and reinfect the wild stocks. However, there is no evidence to indicate that this scenario has ever occurred...While fish held in culture are likely to show more frequent appearance of disease than wild fish, disease does not appear to be transmitted to wild populations."

Genetic Effects--"The potential consequences of the interbreeding of escaped and wild organisms, if at all, are unclear. However, for salmonids at least, the potential magnitude of the problem would seem minimal."

Toxicants--"Salmon net-pen culture in Puget Sound requires the occasional usage of antibiotics, most frequently oxytetracycline. The potential environmental effects of this usage are minimized by the high water solubility of the compound, rapid dilution with the surrounding water and the infrequency of its use."

The August 1986 report was conducted by Donald Weston of Science Applications International Corporation who now is working on a comprehensive environmental impact statement for salmon farming in Washington. The report is entitled: "The Environmental Effects of Floating Mariculture in Puget Sound." (College of Ocean and Fishery Sciences, University of Washington, Seattle, WA 98195.)

Scallop Farming in Alaska--A Farmer's Perspective

by Timothy Ward

Central Kodiak Archipelago Scallop Farming Project

The potential for scallop farming in Kodiak Island waters is excellent because of the good density and high growth rate of the natural population of the weathervane scallop (Patinopecten caurinus). These natural stocks coupled with the Japanese success in culturing a similar species (P. yessoensis) has sparked a major effort to master techniques for scallop farming in Kodiak.

An island-wide effort was mounted this year to negotiate the first hurdle of scallop farming--collection of spat. Although the three groups--State of Alaska, Kodiak Area Native Association and Central Kodiak Archipelago Scallop Farming Project (CKASFP)--were unsuccessful in capturing weathervane spat in trial efforts, other scallops, clams, mussels, cockles and snails were gathered. The real test of the spat gathering phase of the project will come next year when the collecting gear is pulled and examined.

CKASFP set weathervane scallop collecting gear in mid-May and July in four widely separated areas of high potential. The timing was based on the belief that Kodiak weathervane scallops spawn in June and July. The sites were selected in protected areas with good tidal action, no fresh water and adjacent scallop beds. The gear was set in 10 fathoms of water; it is now believed 30-50 fathoms is preferable.

The collecting gear is a vertical line buoyed at the top and anchored at the bottom. Monofilament web-filled onion bags are attached to the line. The mesh of the onion bags is large enough to let the scallop larvae enter, while the web provides a surface on which the larvae will attach and grow into a juvenile scallop. The scallops eventually detach from the web to fall to the ocean floor, but are too large to fit through the mesh of the onion bag.

(Next Issue: Transfer of seedlings and the grow-out phase.)

Kodiak Area Native Association Scallop Project

by Bill Osborne, KANA Mariculture Coordinator

The Kodiak Area Native Association (KANA) approached the State of Alaska in 1985 for assistance in establishing new marine-based businesses to promote economic growth. The result was an agreement with a Japanese development agency--Overseas Fisheries Cooperation Foundation--to test the feasibility of farming scallops on Kodiak Island.

Meanwhile, KANA obtained federal funding to assist in a scallop mariculture demonstration project. The goals of the KANA project are to establish a stable, income-producing enterprise for Kodiak villages, and to develop scallop mariculture techniques for application in other areas of Alaska.

Dr. Mike Kaill, mariculture specialist with the Alaska Department of Fish and Game (ADFG), and I studied scallop mariculture techniques in Japan last summer, while trial collection efforts began in several locations around Kodiak Island by private "cooperators" and ADFG staff. Strong support for the project was provided by Junzo Abe, a Japanese aquaculture specialist temporarily working with the Marine Advisory Program.

The initial spat collection effort yielded a variety of scallops, including the pink scallop (Chlamys sp.), but, unfortunately, no weathervanes. Japanese experts believe the design of the collectors may have contributed to the failure to gather weathervane spat, and say the successful collection of other scallops is a good sign.

The next collection effort will begin with a training workshop in Kodiak for project participants. OFCF will send Japanese technicians to work with ADFG, KANA and other "cooperators" at six collection sites. Work also will proceed in Kodiak to predict the timing and location of scallop spat settlement, analyze plankton and spat samples, and provide other technical support.

We're looking forward to 1987 being the year of the scallop in Kodiak.

TBT Correction

An article in our last newsletter misinterpreted research conducted by the National Marine Fisheries Service's Auke Bay Fisheries Laboratory on the use of tri-n-butyl tin (TBT) as an antifoulant treatment for marine nets.

The article said NMFS research show TBT-treated nets "appear to cause significant mortalities in open-reared chinook." Frank Thrower of NMFS explains: "Although TBT has caused significant mortalities of pen-reared chinook salmon on some occasions at our research station, we have never said or implied that rearing chinook in TBT-treated nets will always result in significant mortalities. With proper caution, chinook can be reared in TBT-treated nets without significant mortalities."

Thrower also clarified that TBT has not been demonstrated to be a "suspected carcinogenic compound" as stated in the article. As a heavy metal, TBT raises health concerns similar to those associated with human consumption of mercury. TBT currently is classified as a pesticide by the federal government, although that classification currently is under review.

Mariculture News Notes

The Mariculture Technical Work Group, composed of representatives from state and federal agencies and formed at the invitation of AMA, is nearly complete with its review of issues associated with the development of a mariculture industry in Alaska. The group's final report will be discussed in the January issue of the Alaska Mariculture Report.

Support for mariculture development in Alaska is growing, if adoption of recent policy statements by municipal governments is a reliable indication. A statement supporting mariculture was adopted at the annual meeting of the Alaska Municipal League in November, and a similar policy position was adopted at the initial meeting of an informal coastal alliance formed by representatives of municipal governments from Bristol Bay to Ketchikan. Resolutions urging the legislature to adopt pro-mariculture policies also have been adopted by the Southeast Conference and Kodiak Island Borough.

The "bible" of Alaska's beginning oyster farmers is the Alaska Oyster Grower's Manual, produced jointly by the Office of Commercial Fisheries Development and Marine Advisory Program. The manual covers the spectrum of concerns of fledgling farmers from site selection and permitting to contacts for purchase of spat and culturing techniques. This valuable manual is now being revised for a third edition. The updated version should be available after April 1, 1987. Meanwhile, a handful of copies of the second edition are available by writing: Mr. Bill Paulick, Office of Commercial Fisheries Development, Department of Commerce and Economic Development, Pouch D, Juneau, AK 99811.

The Fisheries Rehabilitation, Enhancement and Development (FRED) staff of Alaska Department of Fish and Game in Kodiak has prepared a scallop mariculture field manual providing basic technical information on scallop spat collection and culturing. The manual, which is designed to be updated as new information becomes available, also contains an explanation of the permitting process. Mariculture Field Manual. Alaska Department of Fish and Game, FRED Division, 211 Mission Road, Kodiak, AK 99615.

The market penetration achieved by Norway in selling farmed salmon is demonstrated by the retail sale of Atlantic salmon in Juneau. While a selling price of \$9.69 is unlikely to result in much product movement, the arrival of pen-reared salmon at retail counters so close to Alaska's only source of off-season fresh salmon is significant. The store--Fred Meyers--had no fresh troll-caught salmon available.

ALASKA MARICULTURE ASSOCIATION

P.O. Box 020704
Juneau, AK 99802-0704

Mariculture Technical Work Group

Where: Hendrickson Building, Room 205
University of Alaska, Juneau
(See Attached Map)

When: 8:30 a.m., Thursday, October 30, 1986

- I. Introduction
8:30-8:45 a.m.
Rodger Painter--Alaska Mariculture Association
- II. Subcommittee Assignments/Coffee
8:45-9:15 a.m.
- III. Mariculture Overview: Worldwide Trends/Alaska Feasibility
9:15-10:45 a.m.
Bill Heard--National Marine Fisheries Service
Mike Kaill--Alaska Department of Fish and Game
- IV. Questions and Answers/Discussion
11:00-Noon
- V. Lunch
- VI. Subcommittee Discussions
1:00-5:00 p.m.

ALASKA MARICULTURE ASSOCIATION

M E M O R A N D U M

TO: Mariculture Technical Work Group

FROM: Rodger Painter
Alaska Mariculture Association

DATE: October 23, 1986

Thank you for your participation in the Mariculture Technical Work Group. Response to the letters of invitation indicates that 15-20 people will attend the first meeting. Attached is an agenda.

You also will find a description of subcommittees. You will be asked to select a subcommittee at the beginning of the meeting. This decision will be critical since most of the work will take place in the subcommittees.

We hope to schedule a concluding session of the work group for mid-November. That meeting will consist of descriptions of the subcommittee deliberations and recommendations by the subcommittee chairs, and a discussion of work group recommendations.

The subcommittees may require additional meetings to complete the discussions and recommendations. These meeting will be left at the discretion of the subcommittees.

AMA wants to keep the discussions focused on the more technical considerations of mariculture development. The socio-economic issues are best dealt with in other forums.

The Mariculture Technical Work Group recommendations will be presented to the legislature and to the new governor when he or she takes office in December. The recommendations should prove valuable to both industry and government officials as Alaska shapes a state policy for mariculture development.

Mariculture Technical Work Group Subcommittees

Siting and Operational Criteria

Permitting process, siting criteria, sedimentation, genetic effects of escapements, water quality

Subcommittee Chairs:

Bill Heard--NMFS

Mike Kaill--ADFG

Disease and Public Health

Disease management programs, use of antibiotics, non-indigenous species, movement of brood stock, PSP testing, quality assurance

Subcommittee Chairs:

Ted Meyers--ADFG

Doug Donegan--ADEC

Development and Research

Developmental programs, dietary requirements, brood stock availability, research needs, marketing, taxes

Subcommittee Chairs:

Bill Paulick--Commerce

Ole Mathisen--UAJ

ALASKA MARICULTURE ASSOCIATION

P.O. Box 020704
Juneau, Alaska 99802-0704

(907) 586-2032

October 13, 1986

Honorable Don Collinsworth
Commissioner
Alaska Department of Fish and Game
P.O. Box 3-2000
Juneau, Alaska 99802

Dear Commissioner Collinsworth:

The Alaska Mariculture Association (AMA) was formed recently by a group of individuals and companies interested in the development of a sound, year-round mariculture industry in Alaska. Attached is a press release which outlines some of the organization's initial goals.

We are strongly committed to the development of an industry which is compatible with Alaska's abundant wild sea resources, unpolluted coastline, and existing seafood industry. We believe this goal is possible and, because of the current problems with the state's economy, highly desirable.

AMA is interested in addressing the spectrum of issues which have been raised regarding mariculture, ranging from promotion of the industry to environmental safeguards and protection of public welfare. Timely review is necessary since the Legislature will likely be considering mariculture development in the next session.

An important first step in the process is for us to receive advice from the state and federal agencies which may have some involvement or responsibilities regulating mariculture. We would greatly appreciate the involvement of the Alaska Department of Fish and Game in a Mariculture Technical Work Group to identify issues and develop potential governmental responses.

Also invited to participate in the Mariculture Technical Work Group have been: Departments of Commerce & Economic Development, Environmental Conservation, Revenue and Natural Resources; University of Alaska, Juneau; National Marine Fisheries Service; Environmental Protection Agency; U.S. Forest Service and U.S. Fish and Wildlife Service. We have received very positive feedback from agency representatives contacted to date.

If possible, we would appreciate the involvement of the following individuals from your department: Mike Kaill (FRED); Ted Meyers (FRED); and Bob Clasby (Commercial Fisheries). We hope to hold an initial meeting of the advisory work group during the last week in October at the UAJ School of Fisheries. I will be in touch to firm up this date.

We have identified the following concerns which we would like the Mariculture Technical Work Group to address:

- Disease Management
- Water Quality
- Sedimentation
- Importation of Non-indigenous Species
- Escapes of Cultured Species and Genetic Implications for Wild Species
- Guidelines for the use of Antibiotics
- Brood Stock Sources and Allocations of Wild Stocks for Brood Stock
- Product Wholesomeness and Testing for PSP
- Site Competition
- Tax Structure
- State and Federal Business Development Services
- Research Priorities

AMA believes many of these issues can be addressed through present state and federal regulatory and planning processes with little or no modification. Others may require both statutory and regulatory changes.

The Mariculture Technical Work Group recommendations are needed by the end of November. It will be difficult but very possible to complete this process in one month. Many of the individuals we hope to have involved in the work group are very familiar with mariculture issues, and the agencies certainly have expertise in dealing with the permitting and regulatory process.

Attached is a document which addresses many of the concerns raised about mariculture development. This study by the University of Washington represents one of the most comprehensive examinations of environmental and health concerns about mariculture. We will be providing additional background materials to your representatives.

The Mariculture Technical Work Group process could be greatly expedited if your agency representatives have the opportunity to study the list of issues raised and come into the first meeting with some preliminary thoughts on how to approach the issues under--or potentially under--your jurisdiction.

Please contact me with any questions you or others may have concerning the Mariculture Technical Work Group. Thank you for your cooperation and assistance.

Sincerely,

Rodger Painter

Mariculture. 'worst case' could cost fisheries \$36 million

Continued from page G-1

bia. The firms also would be interested in investing in Alaska, he said.

However, Meyer sees some disadvantages in Alaska.

"Alaska does not have a good track record of building infrastructure for any kind of industry. It's somewhat disorganized for any newcomer," he said.

Legislators will end up at the pivot point, choosing between constituents who fear competition and social impact and an industry promising all the things they campaigned to bring home.

"My mind is still open," Juneau's Duncan said. "The bottom line is what will be our economic benefit and impact on fisheries."

"We want to make sure we're not harming a part of the state economy," Duncan said. "My fishing constituents are not very enthralled with the idea."

"I know who I represent," Sen. Lloyd Jones, R-Ketchikan, said. "Commercial fishermen are not in favor of it; consequently, I have to make sure I don't hurt their cause."

Legislators like Anchorage Rep. Johnny Ellis and Kodiak Sen. Fred Zharoff cite Alaska's geographic advantages and the economic potential to support mariculture development.

The already substantial market share of farmed salmon and the predicted growth buoys the proponents' arguments. A sampler of statistics:

- In 1986, approximately 59,200 metric tons of farmed salmon were produced worldwide. In three years, that's expected to increase to between 107,000 and 140,000 metric tons.

- The 1986 wild salmon harvest was 657,000 metric tons. For-

casts for 1990 predict the world harvest stabilizing at about 677,000 metric tons.

- About 43 percent of world salmon production and 90 percent of U.S. salmon comes from Alaska commercial fishermen. The 1986 harvest in state was 268,000 metric tons.

- Between 1983 and 1985, fresh farmed salmon imports into the United States grew from 4 million pounds to 16 million pounds, with the value growing from \$13 million to \$52 million.

"If this state does allow salmon farming, it appears that even a very modest development will result in thousands of jobs, and over \$100 million in sales when both direct and indirect effects are considered," according

'It doesn't matter if Alaska is involved, the impact is there . . . Farmed salmon is not going away.'

— Rick Harris
Sealaska vice president

to a report prepared by Robert Logan, a University of Alaska-Fairbanks professor, and by John Weddleton, an Anchorage consultant.

A study conducted by Sealaska Corp., the regional native corporation for Southeast Alaska, found mariculture could be profitable in urban, rural and remote sites.

"It doesn't matter if Alaska is involved, the impact is there," Rick Harris, vice president of resource planning and administration for Sealaska, said.

"Thirteen countries are producing farmed salmon. The market shows no inclination to stop growing," Harris said. "Farmed salmon is not going away."

The growing farm production is expected to cause a \$5 million

to \$36 million loss in revenue to the Alaska fishing industry by 1990, according to the House Research Agency.

"In relative terms, prices for Alaska salmon are expected to fall by about 9 percent as a result of world farmed salmon production, and an additional 1 percent if Alaska were to develop a 20,000 metric ton industry," the agency reports.

The market for fish, both fresh and frozen, has grown tremendously.

How long the expansion can continue is uncertain, however: Commercial fishermen see a glut of salmon in about four years, while mariculture proponents see new markets opening when fresh salmon is available

throughout the year.

Americans are eating more seafood than ever, with consumption growing from 12.3 pounds per person in 1982 to 14.7 pounds per person in 1986, Painter said. Nationally, that's an "increase over five years of 692 million pounds," he said.

"There was a tremendous increase in consumption at a time when the U.S. commercial fishery production was extremely static," Painter said. "What the figures really show is some important long-term trends in changes and patterns in world seafood market."

"The United States . . . is moving toward tremendously increased reliance on foreign-produced products. All the wonderful gains in seafood consumption

do not really benefit our seafood industry but are primarily benefiting foreign producers."

In Logan and Weddleton's report, a 20,000 metric ton Alaska industry was predicted to provide direct farm employment of 1,200 jobs. Depending on the value of sales, farm size and location variables, the industry employment predictions ranged from 2,000 to 6,300 jobs.

The "worst case" effect on the traditional fishery was estimated at \$36 million in losses from farmed salmon.

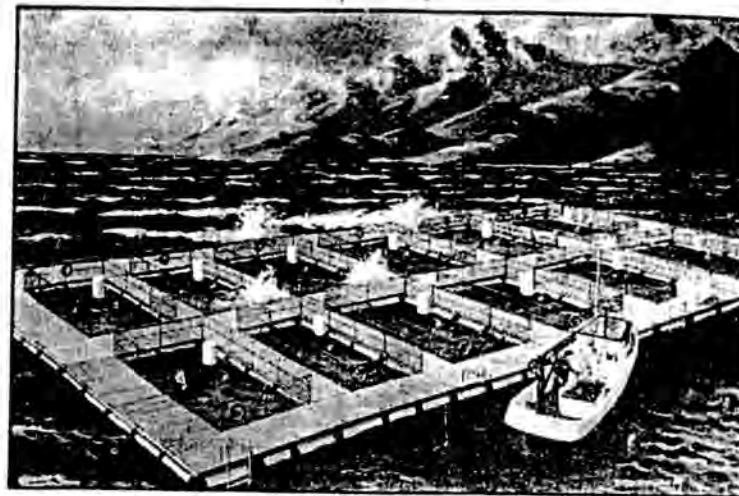
"An incremental Alaskan production of 20,000 metric tons causes an additional \$4 million in losses," they wrote. "This compares to a 'best case' scenario of \$5 million in losses from world salmon farming, but in absence of Alaskan salmon farming."

"Recall that the positive impact of a 20,000 metric ton salmon farming industry was in excess of \$100 million in terms of direct sales," Logan and Weddleton wrote.

"It would be difficult to argue that salmon farming is unjustified in Alaska on purely economic grounds. It would have to be on the grounds of social concerns such as environmental hazards," they wrote.

Krygier said the latter concern should be no small matter to Alaskans who have the world's best wild stock fishery.

He said the farms must be kept well stocked with food for the growing salmon. The nutrient-rich water also is a boon to disease-causing organisms. Net pens would be attractive too to



An artist's rendering shows a salmon farming facility.

other salmon, kings and cohos that winter in Southeast rather than in the North Pacific. That would expose wild stocks to disease, and could allow stocks to mix, Krygier said.

"We fish our wild populations," Krygier said. "That's not like Norway, which had no natural populations to damage."

"The value of our natural stocks are so great we can't risk bringing in a potential disease-creating situation like this," he said.

Such risks must not be overlooked but should not necessarily rule out mariculture in Alaska, according to Painter.

"Certainly the environment needs to be protected, and wild fishery resources are vital to the state economy," Painter said. "They can be protected with a good regulatory approach."

"Or it can go way overboard so that nothing will happen. It's always difficult to find the balance," he said.

Disease and genetic research has been going on for several years in Norway, and federal agencies have test programs in Alaska and Washington.

Sen. Arliss Sturgulewski suggested there was "a major role for the University of Alaska to play" in determining what would make a quality operation.

Marine research has been underfunded and spread over the university system with little cohesion, Sturgulewski charged.

What the state should not become, she said, is a banker.

Painter said the association was not lobbying for loan programs or financial backing. There is private financing available, he said.

"Foreign capital coming into the state is not a bad idea," Sealaska's Harris said. "We need to ensure that Alaskans are part of the industry, so we don't see people in Kake sitting on the beach while the Norwegians fish."

ATA Notes on Pierce paper presented to AFS meeting in Juneau 11-15-88

It is our belief that Brad's paper takes a highly promotional (advocacy) position. The fact that this gentleman is located just four doors down the corridor, and he knew we had a lot of knowledge on this issue - yet never even come in to get us to shoot his ideas down - straw dog to strengthen paper - shows the level of bias. His extreme advocacy reminds me of a Rodger convert who has economic stars in their eyes - seeing only the promised land of salmon farming. This paper does not answer our concerns over disease and genetics; water and land use conflicts; foreign or corporate ownership; market impacts; or competition for funding.

Brad stated that Alaska has seen its market share drop from 97% of quality species to 53%. That most economists see prices falling by 20 - 30% by 1995. Hatchery contribution to harvest was 18% in 1988 season. Alaska has spent 80 million on ocean ranching since its inception. ASMI receives only 1/8th of the money that the fish farming marketing associations in foreign countries receive. We are being out spent and will lose market share. Its interesting that last year promoters of salmon farming were claiming that they wouldn't impact our markets. Now they are arguing the other side of the coin - but saying because of impacts we must do it.

To stop this loss in market share the paper proposes that Alaska do the following:

- 1) Increase quality of product through state wide regulation program. eg. mandatory fish hold inspections - grading.
- 2) Entice more private money into the ocean ranching program.

The paper emphasized that there needs to be more capital investment in the hatchery program to remain competitive; a sign of the competitiveness of an industry is its capital investment expenditures. Since there will be few public dollars available he feels that private money needs to be used more. In fact the paper advocated private for profit ocean ranching.

- 3) Allow pen-rearing to make up for supply shortages during off season.
- 4) Start making fish meal from waste materials produced from current fish processing.

The question should be - Do we need more market share if we sell all we catch now? I believe the issue - touched on by him and argued by us for a long time - is that we can increase our market share by increasing quality and market forms of our existing resource. Our fishing industry was analogized to the General Motors of the late 70's, to interested in short term profits while large portions of the market were being lost to Japanese imports, the result of which was economic protection legislation. While we do seek protection through legislation it is not for a particular group that it is sought. The

fishing community seeks protection of our (every citizen of the state) public resource, wild and enhanced runs of salmon. Protection of this resource from the possible genetic and disease effects of pen-rearing effect all the people of the state not just commercial fishermen.

He forgets our argument that the high quality species, mostly kings and coho, are only about 70,000 to 80,000 metric tons; and the addition of 225,700 mt by 1990 leads to saturation of the "high priced spread".

Yes, the market can expand slowly after initial hard marketing; but remember that Fish Farming International warned that "production may exceed demand by 23,000 tons". The fact that he projects a 20-30 % decline in average prices by 1995 should make his Alaska adventure even less likely to succeed.

Subsidy is used when the Fisheries Enhancement Loan Fund is mentioned. This is not, and has never been, a subsidy. The citizens of this state, through the legislature, have taken the role of bankers investing in enhancing our natural resource by loaning money to enhance the welfare of the state and are not funding or providing a subsidy for a special interest group.

The paper also states that fishermen have a problem with the state selling fish on the open market and competing with their product. But this statement is used in a paragraph which is talking exclusively about the sale of excess chinook eggs to B.C. Fishermen do have a problem with the state competing through cost recovery in their markets - there is no doubt who will lose if private fishermen are to compete with the state. But the real issue is genetics when there is the transfer of eggs from Alaska to B.C. salmon farmers, and not that fishermen don't like the competition.

He stated that fisherman did not buy off on any of the proposals to reduce general fund expenditures on the FRED budget, when in fact we did after much testimony.

Brad also is pretty nasty to commercial fisherman. He makes his point as if the only beneficiaries to enhanced fish were the commercial fisherman. He forgets that many of the hatcheries around the state are directed at sportfisherman. The benefits to the state in the form of more sports catch benefits tourism and the subsistence life styles of the people of the state. Additionally, he says that "the State provides massive support to the commercial fishing industry," He misses the fact that we pay license fees and raw fish tax to the tune of 47.5 million dollars in 1987, while ADF&G's budget was about 43 million (minus DJ & PR Federal funds).

We do agree on the need for quality and some of his arguments hold water. The concept of buy back is well supported by us, though he would have benefited by discussing this with us. All in all - this is a damn bias paper.

Policy Implications of Recent Studies on "Costs of Production for Pen-Reared Salmon in Alaska" and "World Markets for Farmed Salmon"
By Brad Pierce

As a legislative analyst for the House Research Agency, I have been asked to study a number of fisheries and aquaculture issues for the legislature during the past few years. Presenting this paper today gives me the opportunity to gather some of the threads of my observations and conclusions in an attempt to weave them into a more or less coherent view of Alaska's competitive position in future salmon markets. I have to stress that the opinions expressed in this paper are entirely my own and do not in any way reflect the position of House Research or the legislature.

Alaska's commercial salmon fisheries presently account for almost one-half of the world's 550,000 metric ton (mt) catch of Pacific salmon and 90 percent of U.S. commercial landings.¹ Worldwide, seafood markets are expanding and the most important development in domestic and international salmon markets in recent years has been the introduction of large quantities of premium quality fresh farmed salmon. You are probably all aware of the projections for worldwide farmed salmon production, so I will keep the numbers to a minimum and focus on their meaning for Alaska. According to the National Marine Fisheries Service (NMFS), farmed salmon production is expected to more than double during the next few years, from 97,879 mt in 1987 to 225,700 mt in 1990.²

To place this in perspective, consider that preliminary data for the 1988 season put the Alaska harvest of premium species at 155,593 mt (all but pinks are considered premium species).³ In other words, current worldwide farmed production is probably on the same order as Alaska's combined catch of premium species. About one-third of Alaska's harvest of premium species is chum salmon, which occupy a somewhat lower market tier than other premium species--chinook, coho, sockeye and Atlantic salmon. The Food and Agriculture Organization (FAO) of the United Nations predicts that by the turn of the century, farmed salmon may account for one-half of worldwide production.⁴

Something over 90 percent of Alaska's production of premium salmon species is sold in frozen form. A recent study by the Seafare Group showed that the percentage of U.S. fresh/frozen salmon consumption attributable to imports increased from 10 to 48 percent between 1981 and 1987. During the same period, Alaska's contribution to domestic salmon supplies declined from 97 to 53 percent. Recent harvest fluctuations account for some of this change, but the underlying decline in Alaska's market share is clear. The same is true in export markets. In 1985, Norway displaced the U.S. as the largest supplier of fresh/frozen salmon to Europe and last year became the leading exporter of fresh salmon to Japan.⁵ Obviously, a very serious erosion of Alaska's dominant position in its major salmon markets has occurred.

A study of domestic salmon markets by James Anderson, of the University of Rhode Island, describes an enormous unfulfilled domestic demand in retail and restaurant markets for the attributes of farmed salmon that are not shared by wild fish from Alaska--freshness, consistently high quality and year-round availability.⁶ This is particularly true on the East Coast,

where consumers are not particular as to species, method of catch, or flesh color. Pacific Northwest consumers have a strong preference for the bright red flesh of troll-caught wild chinook and coho and the Japanese are partial to frozen sockeye; but these are knowledgeable consumers to whom the Pacific salmon species are familiar and readily available. This consumer preference probably does not exist in most of the U.S. In restaurant and retail markets nationwide, the most highly prized attributes of salmon are high quality and freshness, though it is likely that few consumers could tell the difference in taste between fresh and frozen fish.

Due to the level of unfulfilled demand in domestic salmon markets and a cheap dollar overseas, prices are presently at all time highs. At some point however, the huge increases in farmed salmon production forecast for the future will catch up with demand and begin to affect the price of all premium species. The few economists willing to venture a forecast in such a volatile market situation seem to agree that a 20-30 percent decline in average real (inflation adjusted) prices is likely by 1995. Given projections of available supplies of farmed fish, current domestic restaurant consumption (43,100 mt) and retail consumption (25,700 mt) of premium salmon is expected to double by 1995.

So what does this mean for Alaska? All recent studies of world salmon markets assume that production of wild Pacific salmon is currently at maximum sustainable levels and further incremental increases will be generated by ocean ranching programs, which enhance coastal water fisheries. The most economically successful ocean ranching programs have been with species that require minimal time in a hatchery facility, i.e., pink and chum salmon.

In economic terms, Alaska's commercial salmon fisheries are mature. Limited entry has placed a cap on the number of participants in the harvest and any growth in the natural resource base will come as aquaculturally produced fish from the state's ocean ranching program. Hatchery returns now account for about 18 percent of the total harvest. Projected increases in the state harvest of premium species by 1995 as a result of hatchery returns will not come close to meeting anticipated domestic restaurant demand, let alone growth in domestic retail and international markets (see table below). Thus, the erosion of Alaska's market share is likely to continue unless aquaculture production of premium species is substantially increased.

Alaska's Statewide Hatchery Returns of Premium Species 1987 and 1995

	1987	1995
Chinook	665 mt	1,613 mt
Coho	2,098 "	1,779 "
Chum	6,931 "	29,364 "
Sockeye	3,390 "	7,342 "
Total	13,084 mt	41,712 mt

Sources: Computed from the "FY 88 FRED Division Annual Report" and information supplied by Jeff Hartman, Economist, FRED Division, July 1988.

Alaska's Ocean Ranching Investment

The state has invested heavily in salmon ocean ranching production during the past 12 years. Capital investments in public hatchery projects total about \$80 million and about \$52 million has been loaned for private nonprofit hatcheries. Public hatcheries were initially financed via \$56 million in bond issues passed by the voters of the state. The fisheries enhancement loan fund that finances the private nonprofit hatchery system offers a subsidy of about \$32 million. Combined public and private nonprofit hatchery systems are projected to generate economic activity in excess of public costs over the useful life of the various facilities.⁷

In FY 86 and 87, the Fisheries Rehabilitation Enhancement and Development (FRED) Division, which manages the state's public and private nonprofit hatchery systems, suffered significant budget cuts. This placed the operation of several public hatchery facilities in jeopardy. In the intent language of the FY 88 FRED budget, the legislature stated that it wanted the agency to reduce its dependency on state general funds and generate increased program receipts to make the public hatchery system more self-sustaining. A working group of FRED staff, representatives of the regional aquaculture associations and myself attempted to come to grips with this funding crisis.

To date, commercial salmon fishermen have rejected all proposals for generating increased program receipts or shouldering a larger share of the financial burden of public hatchery production, except for assuming the operation of four of the state's most productive (commercial species oriented) hatchery facilities through their regional associations. The FRED Division saves about \$2.5 million in annual operating expenses by transferring operations of these facilities to the private sector and commercial fishermen continue to receive the direct economic benefits from hatchery returns at no extra cost to themselves, at least individually.⁸ To me, these operating agreements raise some public policy questions about what the general public who bonded to build the facilities receives from the deal, but that discussion is beyond the scope of this paper.

Rationalization of the state's ocean ranching program to reflect fiscal reality is absolutely necessary. Prudhoe Bay oil production begins to decline next year with nothing on the economic horizon to replace the revenues the state receives from it. We have seen only the beginning of what is likely to be many more state budget reductions. The transfer of public hatchery facilities to the private sector can increase economic efficiency in the ocean ranching program and is an important first step in improving the competitiveness of aquaculture in Alaska. To avoid potential political problems, it is also important that the general public receive some economic rent in the form of additional general fund revenues from the commercial fishing industry as repayment for their initial investment.

While growth in Alaska's ocean ranching program has run into a public financing barrier, the provincial government of British Columbia reports that over \$100 million in private capital has been invested in new production capacity in the B.C. salmon farming industry during the past four years. This level of private investment is expected to double next year. Capital investment today is one indicator of market competitiveness in the future. Alaska law does not presently allow private for profit aquaculture or salmon farming; as long as this situation persists, the state will be at a competitive disadvantage in world salmon markets.

Commercial fishermen in Alaska perceive salmon farming as a threat to their livelihoods and have used their political influence to block its development. By doing so, they have shut themselves out of an opportunity to invest in farming capacity (through their cooperatives and regional associations) to augment their wild catch in the off season and gain a better competitive position in growing fresh salmon markets. A recent study by the DPA group has shown that farm raised salmon from Alaska can be competitive on a delivered cost basis, particularly in West Coast and Asian markets.⁹

A salmon farming industry in Alaska could allow public and private nonprofit hatchery operations to generate increased revenues through sales of eggs and smolts, which in turn could help pay for expansion of the ocean ranching program. Last summer, the ADF&G was offered \$2 million by the B.C. Salmon Farmer's Association for surplus chinook eggs at the Little Port Walter hatchery, which could have helped fund the \$14.7 million FY 89 FRED Division budget. Due to regulatory constraints and political considerations, the department found itself unable to respond to this proposal. In fact, because of opposition from commercial fishermen, the FRED Division has found it nearly impossible to harvest and sell surplus fish returning to state hatchery sites in order to generate program receipts and recover operating costs. Fishermen have made their position very clear; they do not want the state selling fish in "their" markets.

At least fifteen countries and perhaps a dozen states have developed regulatory regimes to accomodate salmon farming. Many have had to overcome the same sort of political opposition that exists in Alaska. No other government has allowed special interests to exercise veto power over aquaculture development, however. There are many legitimate concerns about salmon farming, but economic protectionism is not one of them. It won't work. The market forces described in recent studies are inexorable and the consequences of ignoring them are a loss of market share and potential revenue to the fishing industry and to the economy of the state.

One reason that British Columbia, Chile and other countries have become so competitive in markets previously dominated by Alaska is that they have encouraged outside private investment from any source and have not had to rely on public capital. Now that Alaska's salmon ocean ranching program has become firmly established and production of commercial species is being assumed by fishermen through their regional associations, the most economically rational course of action for the legislature to take with respect to salmon aquaculture development would be to introduce more private sector initiative. This could be done opening up the Title 16 statutes to allow private-for-profit hatchery operations and salmon farms. However, politics will almost certainly prevent this in the immediate future.

Absent any fundamental change in its approach to private investment in salmon aquaculture, there are a few actions state government can do to improve Alaska's competitive position in future salmon markets. From existing research, the following policy implications have been drawn: 1) orient the state's ocean ranching program to reflect present fiscal and future market reality, 2) develop a state salmon marketing strategy that places greater emphasis on quality, 3) increase economic efficiency in the harvesting sector, and 4) study the feasibility and economies of scale of a fish meal industry in Alaska. Each of these is discussed briefly below.

Ocean Ranching

The FRED Division is changing emphasis from hatchery production to research, development and technology transfer. The financial burden of enhancement activities that primarily benefit commercial fishermen will, of necessity, be shifted from the state to the fishermen themselves in the future. The focus of commercial species production in the public hatchery system is moving toward producing much larger quantities of sockeye and chum salmon.

Alaska has a natural comparative advantage in having most of the world's premier sockeye habitat combined with state-of-the-art enhancement techniques. To date, sockeye have not been successfully farmed. The FRED Division is working on shortening the freshwater rearing phase of hatchery sockeye, which could greatly reduce the cost of production. This type of high-risk development of improved fish husbandry techniques could pay off in commercial fisheries of the future and is an excellent example of the technology transfer role state government can play in economic development.

Chum salmon are cheap to raise and Alaska's hatchery programs are very successful at producing large volumes. In domestic restaurant and retail markets, chum salmon occupy a lower-priced niche than other premium species and market studies have shown that high volumes in frozen portioned form can compete very well on price. Chum roe or "sujiko" is also highly prized in Japan. New hatchery techniques that control the sex of juveniles could be applied to chum production that would increase the ratio of female to male returns in terminal fisheries at hatchery sites. This could add significant value to chum production and reduce the broodstock requirement.¹⁰ Most of Alaska's public and private nonprofit hatcheries are now reaching design capacity in chum production and substantial increases in returns can be expected during the next few years.

State budget constraints may force changes in the financing of chinook and coho hatchery production in the near future. These species are expensive to rear. To the extent that there is federal funding under U.S.-Canada treaty obligations and for sportfish enhancement programs, traditional ocean ranching of chinook and coho is economical. Without some means to offset costs (e.g., selling surplus eggs and/or smolts to salmon farmers), it may become necessary to charge a royalty on the commercial catch of hatchery returns and a fee (e.g., tag, punchcard or license) to sport fishermen in the future to help pay for increased public production of these species.

Salmon Marketing Strategy

As long as the state provides massive support to the commercial fishing industry, government has a right to ensure that the maximum value is extracted from the public resource. This can be encouraged by close policy coordination between the government agencies that regulate and support the industry. A fresh product commands the highest value, which means that management strategies need to be oriented toward allowing harvesters to "fish to the market." The Division of Commercial Fish has been fairly successful at this by spacing season openings of short duration over as extended a time period as possible. Within basic biological constraints, ensuring an even flow of fresh salmon to the marketplace over the entire harvest season should be a management priority.

Compared to fresh farmed fish, frozen salmon from Alaska are widely perceived to be of inconsistent or inferior quality. One answer to the fresh vs. frozen perception problem is to promote the qualities of frozen salmon as the Alaska Seafood Marketing Institute (ASMI) has with its "Premium Quality" program, which places labels on top grade fish. Currently, the program is on a very small scale, involving only 40,000 lbs. of troll-caught cohos during 1987 and less during 1988 because of poor returns. The program is scheduled to be expanded to net-caught fish next year. As the Seafare Group noted in their study, a few Northwest fishermen (notably Bruce Gore) are producing "frozen at sea" salmon that command exceptional prices in the restaurant trade. If ASMI is going to promote frozen wild salmon that can compete with fresh farmed fish, a long-term strategy might be to explore the market opportunities for frozen at sea salmon products from Alaska.

The British Columbia government has been fairly successful at raising the overall quality of salmon delivered by fishermen to processors through their vessel hold inspection program, which has been in place for the past six years. Under this program, all fishing vessels must be inspected and meet specific standards prior to obtaining or renewing their operating licenses. In Alaska, certain processors have fish hold standards, but there is no organized attempt by the state to impose requirements. One idea would be for the Marine Advisory Program to develop fishery specific hold standards, perhaps combined with a one-time Commercial Fisheries Loan program to finance upgrading of vessels. The long-term goal should be for all fishing vessels in Alaska (except those used in skiff fisheries) to have properly insulated, sanitary fish holds and for all new vessels to employ some form of refrigeration or freezing capability. Price differentials paid by processors can encourage investment in refrigeration equipment, but it is up to state government to ensure that overall quality is raised to competitive standards.

The Quality Assurance Program--developed by ASMI and the Department of Environmental Conservation (DEC) during the past three years--could be greatly expanded, with processors assuming the financial burden of producing quality products that measure up to world standards. Uniform statewide dockside grading standards could be included in the program, which would give buyers a better idea of what to expect when placing orders for fresh fish with unfamiliar Alaska processors.

Even though processing facilities in Alaska receive regular sanitation inspections, fresh and frozen products shipped from the state are not subject to the rigorous inspection standards that competing products from Norway and other countries are. (A few processors who sell to the government employ federal inspectors.) It is likely that some form of mandatory federal product inspection standards will be imposed on the seafood industry within the next several years. Alaska has more to gain from a mandatory product inspection program than any other state and could take the national lead with a rigorous state program. As Ken Talley of Seafood Trends says, "This is a job for government. The industry has shown itself to be incapable of developing a meaningful product inspection program."

Another area in which the salmon processing industry in Alaska has fallen behind farmed salmon producers is marketing and promotional support. The salmon farming industry in Norway charges a 1.25 percent of gross product value marketing assessment to both producers and purchasers/exporters. This cumulative (2.5 percent) assessment is over eight times the 0.3

percent marketing assessment charged to partially fund ASMI. Thus, it appears that even with \$ 4.4 million in FY 89 Targeted Export Assistance (TEA) funding from the federal government, ASMI is being heavily outspent by the competition.

Harvesting Efficiency

Another measure to enhance Alaska's long-term competitiveness is to increase the efficiency and professionalism of the harvesting sector. The most practical means to achieve this is to amend existing buy back provisions in the limited entry statutes to make them workable.¹¹ Under a buy back program, an agent enters the limited entry permit market, buys up permits and retires them from the particular fishery. This reduces the number of fishermen that share the gross harvest value. Implementation of a buy back program would have to be approved and financed by the participants in a specific fishery via an assessment on the gross value of their catch. To date, this powerful management tool has lain dormant. Because the buy back concept is somewhat controversial, no legislator has been willing to introduce appropriate legislation, though several gear groups have expressed interest in the idea as a means to provide economic stability in their fisheries.

Given the long-term price outlook for premium salmon markets, fishermen may need the option of a workable buy back program to protect their investment. Ideally, the time for fishermen to tax themselves to finance a buy back program is now, while product prices and gross revenues are very high in many salmon fisheries. However, it is probably unrealistic to expect fishermen to give up present earnings for unsubstantiated worries about the future. One idea would be for the legislature to create a state buy back loan fund that permit holders in a fishery could use to implement a program, which could be repaid to the state with interest.

As a complement to a buy back program, the legislature might direct the Division of Commercial Fisheries and the Commercial Fisheries Entry Commission (CFEC) to review the management and economic impacts of regulatory restrictions (e.g., vessel and gear limitations) to see which, if any, might be relaxed by the Board of Fisheries. There is little likelihood that this type of long-range economic planning will gain any immediate legislative support, however. Our political system tends to respond best to crises, so until a price crash occurs in future salmon markets, the most realistic option is for the CFEC to have workable legislation drafted and ready to introduce should it be needed.

Fish Meal Production

One final area that has received only passing mention in recent studies is Alaska's potential as a producer of fish meal and oil. Processing plants in the state currently produce about 263,340 mt of fish waste annually, from which about 150,000 mt of fish meal could potentially be recovered.¹² With the recent explosion in aquaculture production of numerous species worldwide, Alaska could become a major source of fish meal, which is the primary ingredient in most fish feeds. Only two locations--Kodiak and Dutch Harbor--currently have a sufficient concentration of year round processing facilities to support development of full-scale meal plants, though the Seward Fisheries plant has been producing dry fish feed on a smaller scale for several years. The Alaska

Fisheries Development Foundation (AFDF) is conducting a pilot project to assist Kodiak Reduction, Inc. in upgrading its equipment to produce a larger volume and higher quality meal product that will be competitive in Far East markets.

Much of the fish waste in Alaska is produced seasonally from salmon processing operations. Currently these wastes are ground up and discharged into coastal waters. Aside from causing marine pollution, these wastes also contain whatever pathogens the processed fish carried. The technology for producing quality silage and liquefied fish paste (to be later converted to meal or mixed with dry feed) from seasonally operated plants is still in its infancy, but offers great promise. The economics of scale need to be studied carefully to determine its application in Alaska. Paste made from salmon wastes is not generally fed to other salmon due to bioaccumulation of toxins, but it can be fed to other fish or shellfish and there are rapidly expanding markets in Asia.

Another marketable byproduct is salmon oil, which can be used as a nutritional supplement or cooking oil. North Pacific Processors in Cordova is presently distributing samples of salmon head oil to potential customers in an attempt to create new markets.¹³ There are some federal regulatory hurdles that must be overcome before salmon oil can be widely used for human consumption. Since development of these products could add value to Alaska's salmon production and alleviate marine pollution problems, the legislature may want to assist with research funding.

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In conclusion, Alaska's competitive position in future premium salmon markets ultimately depends on producing products that are in demand and meet world class standards. Current high prices and escalating limited entry permit values are obscuring a dramatic decline in Alaska's dominant position in domestic and international salmon markets. Farmed salmon producers have set new competitive standards that must be met or much of the state's premium species production will not command the highest prices in future markets. Aside from getting tough on the quality issue, which has little political appeal, much of what state government can do to enhance Alaska's competitive position is already being done. Private investment (or the lack of it) in salmon aquaculture is likely to be a key element in determining future market competitiveness. Farmed salmon producers are monitoring the market situation very carefully and have factored lower prices into their long-range business plans; policymakers in Alaska should do the same.

We all remember how, in the early 1970s, Detroit automakers ignored the underlying trends in the marketplace in favor of short-term profits. Finally they lost so much of their domestic market share to higher quality Japanese imports they were forced to seek protection from the federal government through import quotas. Alaska is the General Motors of salmon producers, and by not taking advantage of the salmon farming opportunity, the commercial fishing industry is in danger of becoming a victim of its own political power.

¹Sea Fare Group, "World Markets for Salmon: Pen-Reared Salmon Impacts," April 1988, p. 74.

²"Aquaculture and Capture Fisheries: Impacts in U.S. Seafood Markets," NMFS, April 1988, p. 17.

³"Preliminary Review of the 1988 Alaska Commercial Salmon Fishery," ADF&G, Division of Commercial Fisheries, October 17, 1988.

⁴As reported in "Worldwide Farmed Salmon Forecasts to the Year 2000," DPA Group, Inc., 1988.

⁵"Request of the Alaska Seafood Marketing Institute for FY 1988 Targeted Export Assistance, Alaska Seafood Marketing Institute, July 20, 1988, p. 11.

⁶James L. Anderson, "Analysis of the U.S. Market for Fresh and Frozen Salmon," Staff Paper Series, University of Rhode Island, College of Resource Development, May 1988.

⁷Jeff Hartman, "An Analysis of the Net Benefits of Existing and Proposed Enhancement Projects for the State of Alaska," ADF&G, FRED Division, April 1986.

⁸"FRED 1988 Report to the Alaska State Legislature on the Funding of the Fishery Enhancement Program."

⁹DPA Group, Inc., "Cost of Production Model for Pen-Rearing of Salmon in Alaska and Currently Producing Regions," March 1988, p. 5.

¹⁰Jim Seeb, "Economic Evaluation of the Culture of All-Female Pacific Salmon," Proceedings of the Fourth Alaska Aquaculture Conference, Sitka Alaska, November 1987, University of Alaska, Alaska Sea Grant Report No. 88-4, September 1988, p. 157.

¹¹Ben Muse and Kurt Schelle, "Investments in Fleet Reductions: Suggestions for Revisions of Alaska's Buy Back Statute," CFEC Policy Discussion Draft 86-2, June 17, 1986.

¹²"Waste Watching: Conference was a Primer on Turning Dross into Dollars," Lodestar, Alaska Fisheries Development Foundation, Spring 1988.

¹³Lodestar, AFDF, October 30, 1988.

Public Report No. 15

**AQUACULTURE
and the Administration of
Coastal Resources in
British Columbia**

December 1988

Supposedly this
report highlights
how BC resolved
conflicts relating
to mariculture



ombudsman

Fairness for all in British Columbia

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AQUACULTURE

and the Administration of
Coastal Resources in
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December 1988



OVERVIEW

December, 1988

The dramatic increase in aquaculture activity along the B.C. coast in the past few years has brought with it the promise of greater economic growth and stability for many coastal communities; it has also underlined the potential for conflict among the many legitimate and sometimes competing users of coastal resources. This has resulted in a number of complaints to the Ombudsman's office representing a variety of personal, public and commercial interests, and focusing on concerns such as resource use planning, the tenure granting process, environmental safety and conflict resolution. These concerns have caused the Ombudsman's office to prepare this systems study of the regulation of aquaculture in B.C. This report deals with principles of administrative fairness and not with the technical or political aspects of aquaculture, which are beyond the mandate of this office.

Three levels of government are interested in this development: local government is concerned with zoning and planning, the Federal government with navigable waters and fish spawning grounds, and the Provincial government variously with waste management, economic development, and land and resource allocation. Private interests include those of coastal property owners, aquaculture entrepreneurs, sport fishermen and recreational boaters, the tourist industry, coastal forest company operations, and commercial fishing companies and their unions.

The administrative practices and consensual initiatives discussed in this report are intended to assist resource management while avoiding conflict and litigation. Aquaculture is but one use of coastal resources and the rapid growth of the industry has provided the context for a case study of more general resource management principles. Environmental quality is as important to entrepreneurs investing in a vulnerable stock as to conservationists concerned with a vulnerable wilderness; broad and meaningful participation in long-range planning at once satisfies community and individual interests in protecting property, government concern that decisions are based on complete information, and business dependence on a certain and stable investment climate. Integrated management of abundant but finite coastal resources can put different areas to the appropriate and optimum use of each distinct interest, and revitalized coastal economies will help to finance the preservation and enhancement of other interests.

This report concludes with three major recommendations which address the statutory authority for the administration of aquaculture, the integrated management of coastal resources and activities, and the consensual resolution of related public interest disputes.

Stephen Owen
Ombudsman

I N D E X

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THE ADMINISTRATION OF AQUACULTURE AS A COASTAL RESOURCE IN BRITISH COLUMBIA

Background

Aquaculture as an industry has experienced rapid growth on the coast of British Columbia since the mid-1980s. While the term aquaculture is all-encompassing, and may refer to the raising of plants or animals in fresh or salt water, in British Columbia it has become popularly associated primarily with the rearing of salmon in net-pen facilities anchored in salt water near the shore. It is the rapid, and in some instances, unexpected appearance of these facilities which has caused concerns for a number of individuals living in or involved with the coastal areas of the province. Concerns received by the Ombudsman's Office have had at their foundation the issue of public involvement in aquaculture administration and decision making. While many individuals who lodged complaints with this office had obvious vested interests, such as ownership of a family home in or near the same location as the "fish farm", their concerns also reflected broader interests in the welfare of the general coastal environment and its inhabitants, human or otherwise. For the most part, complainants' frustrations appear to have stemmed from the lack - or at least a perceived lack - of a meaningful voice in the regulatory process. While there is no shortage of policies and policy requirements, both provincial and federal, the feeling remained that these policies were not known or readily available to the general public, nor were they effectively binding in a consistent manner on the Ministry, or Ministries at all times during which discretion was being exercised.

The physical or geographic characteristics of the British Columbia coast which make it suitable for salmon farming, or long-line oyster culture, also make it attractive and desirable to other potential users of the coast, including recreational, residential, commercial, and industrial users. The conflicts which have arisen with the rapid appearance of net-pen facilities have not disappeared or dissipated over time. Coastal communities, in their efforts either to attract or control the development of the aquaculture industry, find themselves embroiled in passionate disputes concerning appropriate use of coastal

resources. For many communities, the fact that they possessed power to control development through zoning measures and the creation of official community plans was cold comfort, as in some instances the industry had arrived before the planning and public participation process could be completed, or commenced. This is, of course, a problem common to all matters of zoning within the context of disputes about development.

This systems study makes recommendations for enhancing the mechanisms for public participation in aquaculture administration and decision making. It also addresses issues relating to the furtherance of the overall goal of administrative fairness through the application of principles of integrated coastal resource planning and management. A major aspect of this paper deals with a proposal for the resolution of conflicts through the establishment of contemporary consensual dispute resolution strategies and techniques. Finally, this study addresses related issues of environmental impact and health considerations, insofar as issues of administrative fairness arise within the context of these highly technical matters.

The administration of aquaculture presents challenges which are inherently inter-disciplinary in nature. This office does not address matters which are, in substance, technical. The recommendations contained within this paper have as their collective goal the enhancement of the fairness of the administration of coastal land tenures and aquaculture practice, to the benefit of those who will use, share, or allocate coastal lands and waters.

It is important to state at this point that this office recognizes the inherently evolutionary nature of regulatory programs. Flexibility and discretion are valuable in the developmental stages; as experience is accumulated, however, it is appropriate to provide a greater degree of structure to the program requirements, and to the discretion which is exercised.

This structuring is best accomplished through legislation, with accompanying regulation passed pursuant to the authority of the statute. Aquaculture development, in the opinion of this office, is reaching the stage where a legislative framework for regulation is both necessary and appropriate.

The Practice of Aquaculture

Oceanographer Jacques Cousteau has observed that for man, the future lies in doing in an ocean environment that which he has already done for thousands of years on land - namely, the controlled rearing of animals within a contained area for the purpose of food production.¹ In countries such as Norway, Sweden, Scotland, Chile, and Japan, aquaculture is firmly established as a valuable industry for the production of seafood for both domestic use and export. A combination of offshore interest in the aquaculture potential of the B.C. coast from countries such as Norway, combined with expanding market opportunities for salmon products has resulted since 1984 in a dramatic growth in the demand for aquaculture land tenures. (See Appendix 10 for charts illustrating tenure distribution and industry composition). These tenures, which take the legal form of either a long-term lease or licence, are issued by the Ministry of Crown Lands (formerly Ministry of Forests and Lands) operating under the authority of the Land Act.²

Because salmon farms are floating, often self-contained, light industrial - or, more accurately, agricultural - structures which are fixed usually within 100 metres of the low tide water mark, they represent a somewhat novel introduction to the shore line environment: Appendix 1 shows a typical net-pen facility with walkways supported by floats. The floats may be hollow fibreglass, foam, or lightweight concrete. Two nets can be seen: an outer net to deter predators such as dogfish and sea lions, and an inner net which contains the fish stock. Feed in the form of pellets is distributed in the net-pen at intervals determined by the operator. Feed which is not consumed as it drifts downward will usually pass through the net and, along with fish feces, be deposited on the seabed in a manner determined by the depth, current flow, and tidal action at the net-pen site. Impact of the solid waste will vary from severe in a poorly flushed, inappropriate site to negligible at a site with excellent current, depth, and flushing.

Because of the tendency of the inner nets, with their relatively fine mesh, to become blocked or fouled with marine organisms such as mussels, kelp, or various types of seaweed, some operators have their nets dipped before installation in an anti-foulant compound. TBT, or Tributyltin, a highly toxic tin-based substance, was at one time used by a number of farms, but was banned for use

on nets by the Salmon Farmers' Association, and by the Federal Government. A copper-based anti-foulant (cuprous oxide) is now employed by a number of farms, with cost-benefit analyses being conducted by some facilities to determine its overall usefulness. Anti-foulant usage has been the focus of concern expressed to this office by certain individuals who fear a cumulative biological impact.

It will be noted that net-pen facilities bear some resemblance to a marina in that the submerged nets which contain the fish are suspended and linked by a series of walkways, usually assembled in a geometric pattern. However, they exist for what is primarily an industrial purpose, to benefit the owner of the fish farm. Apart from providing boat moorage as a public courtesy, as some fish farms do, they do not directly serve the general public. In this respect, they are similar to coastal log dumps which exist to serve the needs of the forest industry. Again, however, unlike log dumps or booming grounds, fish farms have not been a part of the province's history to the extent that their environmental impacts are well known, their general economic contributions are recognized, and their visual impact is assimilated into the consciousness of other coastal users.

Many individuals have economic interests in the aquaculture industry, directly or indirectly. Or they may simply wish to see an improvement in the employment picture for coastal communities. There appear to be few individuals within rural coastal communities who are neutral on the subject of fish farming. Opponents of the fish farm concept are greatly concerned at the ease with which a net-pen facility, which has the portability of a log boom, can be floated into a bay and anchored, transforming an area overnight. They fear the environmental impact of the farm, with tens or hundreds of thousands of fish in an confined environment doing what all organisms do - ingesting nutrients (in this case processed by man) and excreting waste products into a relatively limited area. (For an illustration detailing the various aspects of this interaction, see Appendix 12: "Possible impacts of a salmon farm upon the marine environment"). Pleasure boaters see favourite anchorages being occupied by large net-pen facilities. Scuba divers and tourists see the face of uninhabited areas being changed through a permanent industrial presence. Traditional fishermen see fish farms as a biological threat to wild stock. The industry as a whole claims that

it is a perfect, environmentally sound way to exploit the riches of B.C.'s coastal waters, and it is with each passing month developing new fish-rearing technology aimed at enhancing operational productivity and reducing adverse environmental effects which may be caused by the farm (excess waste), or suffered by the farm (e.g. plankton blooms). Opponents will often concede the potential value of the industry, but "not in my backyard".

As the industry attempts to advance its interests in establishing itself as a viable and important element of the British Columbia economy, it must at the same time fight a continual battle with those who believe with similar sincerity that the widespread growth of the industry will produce long term costs for the province far in excess of any benefits conferred. And both opponent and proponent are forced to deal with the fact that (as with some other resource uses) no one governmental agency has exclusive jurisdiction over the enterprise. (See Appendix 2, Aquaculture Licencing and Approval Flowchart) The Ministry of Crown Lands allocates parcels of aquatic land beneath the high tide line; the Ministry of Agriculture and Fisheries reviews and approves development plans and provides technical assistance to fish farmers; the Ministry of Environment may consider waste management and alleged pollution issues; the Ministry of Municipal Affairs may be involved in related by-law matters; and the Ministry of Health may have concerns specific to site operation and waste disposal. Both the fish farmer and the coastal resident or resource user find that, although there are many policies and procedural requirements for fish farmers to observe, there is little in the way of regulations, and virtually no statute law created to deal directly with the aquaculture industry. With no expert, independent, and binding appeal tribunal to adjudicate competing claims, opponent and proponent may utilize every political, legal, or economic weapon at their disposal to advance their respective interests, the result often being that no one's interests are well served.

As was stated in Public Report #11 produced by the Ombudsman's office entitled, Pesticide Regulation in B.C., "It is necessary for government to develop procedures which identify and attempt to balance these competing interests in environmental management". This study examines the present administration of aquaculture, focusing upon the reality of its existence as an application of coastal resources in the province. Recommendations are made for enhanced administrative fairness in all aspects of coastal land allocation, the

process which usually provides the basis for the conflicts which presently exist. Central to fair and effective (i.e. maximum benefit and minimum detriment to all parties) resource utilization is the concept of integrated planning and management; the report describes models which have been proposed or applied, and makes recommendations for the institution of appropriate planning and management mechanisms. The report also proposes the use of specific approaches to creative conflict resolution, whether the conflicts are matters of inherently subjective concern, or technical expertise.

Jurisdiction

The Ombudsman Act, s. 10,³ authorizes investigation of a decision, recommendation, act, omission, or procedure used by an authority (Ministries and agencies of the Province) "that aggrieves or may aggrieve a person". S. 22 of the Act sets out a code of administrative fairness by which the elements referred to in s. 10 can be measured. S. 22 is a guide for the broad assessment of government acts or omissions; in specific instances, the principles of administrative law and practice must be applied, within the context of thorough investigation, the consideration of all perspectives, and reasonableness. These principles may include the need for a clear statutory foundation from which administrative policy is derived; a structured framework for the exercise of discretion to ensure consistency and certainty; a process for the meaningful participation of interested parties in decision making that affects vital interests; internal quality control mechanisms; and external review procedures which respect the requirements of due process.

It should be noted that, in addition to the authority exercised by provincial ministries mentioned previously, the shore areas most often occupied by aquaculturists are also the subject of federal jurisdiction, primarily for the purposes of fisheries habitat protection (Department of Fisheries and Oceans, administering the federal Fisheries Act)⁴ and navigation (the Coast Guard, administering the provisions of the federal Navigable Waters Protection Act)⁵. While recommendations made by this office may have some impact on procedures employed as between the British Columbia and Federal governments, the matters of major concern which are addressed in this report are matters within (by law or by convention) Provincial authority. The Ministries of government which make administrative decisions relevant to the subject of this paper come within the Ombudsman's jurisdiction. This

jurisdiction includes the authority to examine the merits of such decisions, and not merely the procedures followed in reaching them. It also includes the responsibility to recommend statutory change, where existing legislation or procedures create the potential for unfairness.

Scope of Study

The Ombudsman's office is perhaps in a unique position to deal with inter-ministerial issues such as aquaculture administration. This office does not take a position for or against aquaculture; rather, the mandate of the Office of the Ombudsman is to be an advocate of fairness, and to ensure that aquaculture policy is administered in a manner which is fair to all individuals whose interests are affected.

This study was commenced on the initiative of the Ombudsman as a result of complaints received concerning aquaculture regulation in B.C. The common thread running through the complaints received was a dissatisfaction with the manner in which aquaculture is regulated. Such concerns ranged from an apprehension concerning the apparent lack of legislation or regulations, to the manner and degree in which public information is received and acted upon. Ten operating or proposed finfish net-pen facilities were identified specifically by complainants; for certain facilities, a number of complaints were received, and some of these were representative in nature, incorporating petitions of protest signed by local residents. It should be noted that in matters addressed publicly by this office, a common principle is followed: the concerns revealed by complaints are generally held to be of greater significance than the number of complaints.

What became apparent to this office early in the study was that some of the existing problems had their origin in the lack of a well-defined, integrated, and inter-disciplinary system for the management of British Columbia's coastal resources. The border between land and ocean constitutes an area highly prized by a diverse range of human interests, ranging from residential and recreational to industrial and international trade. Many areas of the coast are sensitive to excess waste loading, and their sometimes delicate ecologies may be considered a non-renewable resource.

The nature of this topic demanded a special approach from the Office of the Ombudsman. In addition to consultation with representatives of the various ministries involved,

this office also produced a discussion paper, which was primarily an information gathering tool. Questions distilled from a preliminary examination of available literature and analysis of the complainants' concerns were incorporated into the discussion paper under three headings: land allocation, conflict resolution, and environmental and health impact. Almost 100 copies of the discussion paper were distributed to a broad range of interested individuals and organizations. These included both individuals whose interests were confined primarily to environmental aspects, and members of the aquaculture industry. In addition, contact was made with representatives of the State governments of Alaska, Washington, Oregon, and Hawaii, for the purpose of studying their coastal resource management systems and their attitudes toward and experience with aquaculture. Contact was also made with representatives of Canadian Maritime provinces where aquaculture legislation is in place, as well as the governments of Norway and Sweden, who provided valuable information on both the law and practice of fish farming. This office also had useful contact with the Natural Resources Management Program at Simon Fraser University, and the Westwater Research Centre at the University of British Columbia.

No study of the current administration of Aquaculture in B.C. would be complete without a detailed review of the Report of the 1986 Public Inquiry into Finfish Aquaculture in British Columbia ("The Gillespie Report"). In response to concerns about the growth of the aquaculture industry advanced by the United Fishermen and Allied Workers Union (UFAWU) the Province of British Columbia instituted a moratorium on finfish aquaculture tenure issuance commencing October 31, 1986. At the same time, a commission of inquiry under the Chairmanship of Kamloops lawyer David Gillespie was established with a thirty-day mandate to investigate, report and make recommendations on the following aspects of marine finfish aquaculture operations:

- (a) impact on commercial fishery operation, markets, and localized production - related facilities;
- (b) potential and environmental impacts and effect on wild fish stocks;
- (c) impact and involvement of local government and interest groups;
- (d) government approval and monitoring procedures.

This office is not attempting to duplicate matters that were the subject of the 1986 Gillespie Report. However, implementation of the recommendations of that inquiry, which has been completed to the considerable credit of all Ministries involved, does not affect the appropriateness of further examination by the Office of the Ombudsman. This office has the relatively narrow focus of administrative fairness, while the Gillespie Report was more broadly directed to include social and economic policy concerns. Above all, the Ombudsman's Office seeks to be constructive in its involvement. It also notes the considerable and impressive dedication of Ministry personnel in applying their expertise, within the limits imposed by the institutional framework, toward achieving an equitable balance of interests in the regulation of this new and formidable industry.

Legislative and Statutory Framework

What makes net-pen aquaculture relatively unique is the process, both legal and physical, by which a private use is created of resources which have historically been treated as public. To understand the basis for this, it is necessary to review both the legal and physical aspects of the shore zone (see Appendix 3.). The upland zone (above the high-water line) remains primarily within the exclusive jurisdiction of the Province. Exceptions to this rule of ownership concern land which, by virtue of an overriding national interest, as expressed either in the Constitution Act 1867 (formerly known as the British North America Act) or decisions of the Court, is vested in the Federal Crown. Examples of lands under federal control are airport facilities, military bases, and subaquatic lands underlying offshore waters.

Title to the foreshore (that area between the high and low water line which is exposed at low tide) is vested in the province. No private ownership of the foreshore exists except in the case of a special Crown grant, or proof of a previous title that would predate the Province's entry into Confederation. However, private use of the foreshore can be granted as part of the legal rights conferred with a lease of aquatic land, which will by its nature include a right of possession extending to the high water mark.

It has long been established that, independent of Crown disposition by way of lease, the public has a right to pass on-foot without hindrance along the foreshore, and to navigate in ships over the foreshore when it is submerged

at high tide. At the same time, private owners of upland property possess what are known as "riparian rights". "Riparian" technically refers to inland bodies of waters such as lakes or streams, and the term "littoral" is used to refer to the equivalent rights attaching to ownership of property which abuts on a sea or ocean shore. However, Canadian courts have used the term "riparian" in both contexts, and it is used in such a fashion as well by the Ministry of Crown Lands. For the purpose of this report, the most important riparian right is the right of access from the upland property to "navigable water" at each and every point along the junction between the foreshore and upland property.

The submerged or sub-aquatic land beneath the low tide mark is known as the "solum" and was originally treated as the property of the federal Crown. This notion arose in Canada first as a result of the English legal tradition that all seabed is vested in and under the control of the Crown, for reasons of national security. A further reason was the fact that the Canadian Constitution provided that public harbours, international trade and shipping, and offshore fisheries would be the subject of control by the federal Crown. Federal - Provincial concerns over ownership of the seabed or its resources did not arise until late twentieth century technology made it an issue. To some extent, the legal issue remains unsettled. However, as it is relevant to the practice of coastal aquaculture, this much appears clear:

- (a) A decision by the Supreme Court of Canada in 1984⁶ settled the dispute over "internal waters" and the seabed between the Mainland and Vancouver Island, by confirming jurisdiction of the province over the management and sale of all resources in this area.
- (b) This does not mean that the federal government is without jurisdiction in the area classified as "internal waters". Jurisdiction remains over certain enumerated and significant public harbour areas and for the purposes of enforcing the Navigable Waters Protection Act and the Fisheries Act.

The primary function of the Department of Fisheries and Oceans in administering the provisions of the Fisheries Act is to prevent destruction of fish habitat, which includes critical spawning areas for salmon and other aquatic life. The Fisheries Act also prohibits the

dumping or placement in any other fashion of "deleterious substances" which would have the effect of harming fish habitat or wild fish stocks.

The Coast Guard, as a component of the federal Ministry of Transport, enforces the provisions of the Navigable Waters Protection Act to ensure that any structures, whether erected from the seabed or in the form of a floating structure fixed with anchors, do not pose a threat or restriction on the right of free and safe navigation.

Currently, the federal Department of Fisheries and Oceans (DFO) requires fish farmers to possess a valid licence under Section 7 of the Fisheries Act. It has been argued, - although no fish farmers have to date sought to follow this point up - that the Department of Fisheries and Oceans has no constitutional right to insist upon such a licence. The Provincial Ministries of Crown Lands and Agriculture and Fisheries do not recognize the DFO requirement as a licence binding upon the Province; rather, DFO is treated as a referral agency, and its comments are carefully reviewed.

The Coast Guard establishes itself in the regulatory framework by requiring that fish farms of the floating net-pen variety, as well as long-line shellfish farms or any other aquaculture facility which would fix structures at a point on the surface of the water, obtain a certificate of exemption under the Navigable Waters Protection Act; this certificate declares that the installation design and location has been examined and found not to pose a restriction or hazard to coastal navigation.

From the above discussion, it can be ascertained that, because of the manner in which net-pen facilities are located, in reasonable proximity to the foreshore, the primary jurisdictional and regulatory functions fall to the provincial government. It is worth noting that on September 6, 1988, the Government of British Columbia signed a significant memorandum of understanding on aquaculture development with the Government of Canada. The agreement, amongs its other functions, formalizes the jurisdiction of the Provincial Government to licence, develop, manage and regulate the aquaculture industry in B.C.

Primary among the aquaculture regulators is the Provincial Ministry of Crown Lands, allocating aquatic Crown land under the authority of the Land Act. However, the Land

Act does not mention aquaculture and there are, to date, no Land Act regulations directed specifically at aquaculture. The Ministry of Crown Lands dictates procedures by way of guidelines set out in the Land Administration Manual. These guidelines govern grants of aquatic Crown Land by way of licence or long-term lease; current Ministry policy is to provide for lease terms of up to 30 years. The guidelines do not have the force of legislation.

Because of the overlapping jurisdiction of other Ministries to control certain aspects of aquaculture, the Ministry of Crown Lands utilizes a referral process by which details of proposed salmon farming operations are relayed to other ministries and levels of government for comment. The referral process can be seen, through directives from the Land Division, to be undergoing continual refinement; certain interest groups are now among the referral agencies.

The Provincial Ministry of Agriculture and Fisheries has been formally designated lead Ministry and has responsibility for reviewing and approving fish farm development plans. The title "lead Ministry" indicates that it has been given responsibility for development, coordination, and implementation of strategies dealing with aquaculture. It also provides technical information on the subject, and has undertaken a number of initiatives aimed at the promotion of orderly growth of the aquaculture industry.

Information received by this office from the Ministry of Agriculture and Fisheries indicates that both general and specific strategies are being formulated to assist in this aim. Proposals of interest to this office include:

- (a) recognition of competing demands for coastal resources;
- (b) streamlining of regulatory and reporting procedures;
- (c) establishment of a provincial aquaculture permit or registration requirement; and,
- (d) specific aquaculture legislation.

The Ministry also administers the provincial Fisheries Act⁷. As has been pointed out: "This Act deals not so much with the regulation and preservation of the wild

fishery, as does its federal counterpart, but with those activities which are ancillary to the wild fishery, and more closely approximate matters of Property and Civil Rights in the province [reserved to the provinces by the Constitution Act 1867]"⁸.

The Provincial Fisheries Act restricts its ambit to matters relating to licensing of fish processing operations and fish buying stations, and dovetails with companion legislation, the Fish Inspection Act⁹, which provides for the maintenance of health and product quality standards in fish processing plants. From the beginning, the Ministry of Agriculture and Fisheries has been treated by the Ministry of Crown Lands as a primary referral Ministry; other referral agencies include the Ministry of Environment, local governments, and, to a lesser degree, the Ministries of Municipal Affairs, Regional Development (formerly the Ministry of Economic Development), and Health.

Apparently, no provincial agency other than the Ministry of Crown Lands has direct power to disallow an application for a coastal land tenure. Comments by Federal referral agencies are given considerable weight. The Coast Guard has the closest to an absolute veto by its power to declare a proposed floating structure to be a potential hazard to coastal navigation under the Navigable Waters Protection Act. It should be noted that restrictions imposed by other agencies do not affect the power of the Ministry of Crown Lands to issue a tenure. However, such tenure is granted subject to development restrictions or other laws which may be imposed by Federal, Provincial, or local authorities. One of the ostensible purposes of the present referral system is to identify locations in which such restrictions will be imposed and to advise the applicant accordingly, to prevent wasted effort.

Local governments have power to prohibit or regulate the siting of aquaculture facilities through their powers of local zoning (where their boundaries cross a water area, zoning will also apply to the surface of the water within that area under Section 963 of the Municipal Act). Development may also be subject to certain conditions. This may be done through official community plans and development permit requirements enacted under sections 945 and 980 of the Municipal Act.

Out of this inter-jurisdictional maze, one clear fact appears: no single level of government - local, Provincial, or Federal - emerges as having total jurisdiction.

The fragmented jurisdiction among local, Provincial, and Federal governments is not unique to aquaculture. Examples such as the Fraser River Estuary Management Program, in which mechanisms to form an administratively accountable framework were created to manage an exceptionally complex physical and social environment, will be considered later in this paper. It is the opinion of this office that aquaculture shares with estuary management the technical, social and legal complexity which demands imaginative and effective administrative solutions drawn from Canadian and international experience in integrated resource governance.

The importance of the physical subject matter - the shoreline of British Columbia - and of the institutional framework for its management is expressed well in the following excerpt from a paper entitled "Canadian Freshwater Lake and Marine Shore Areas - Uses and Management", presented by J.C. Day and J.G. Michael Parkes to the Shore Management Symposium in Victoria, 1978:

"The shore zone is of critical importance to all Canadians for historical, economic, ecological and social reasons. It contains important food resources and transportation advantages upon which present lifestyles depend while supporting a range of habitats for fish and wildlife species which Canada has international obligations to preserve. The land-water interface supports most recreation activities. In recent decades the shore zone has been subjected to rapidly increasing urbanization, transportation, industrialization, and leisure-space demand. Canadian shore areas are becoming a focus of environmental and resource-use problems for many reasons. The most fundamental concerns current institutional arrangements. As Craine (Craine, L. 1972, final report on institutional arrangements for the Great Lakes II-4. Ann Arbor, Mich.: Great Lakes Basin Commission) observed, institutional deficiencies are not necessarily related to the agency or the personnel involved but rather to the institutional system, or lack thereof, in which they operate. For example, Canadian federal responsibilities are mainly water related, with the exception of certain federal lands. Land management to the low-water mark is essentially a provincial responsibility. But neither administrative system is usually broad enough to

recognize that land and water management strategies applied separately do not deal with the symbiotic opportunities and constraints peculiar to the land-water interface. A fundamental problem relates to the fact that current institutional arrangements have failed to ensure that shorelines are an integral component of a coordinated land and water management system."

Complaints

Individuals who have approached the Office of the Ombudsman with complaints specific to aquaculture have focused primarily on two areas: the land allocation and tenure granting process; and environmental impact and health issues. Woven throughout these complaints was a common concern that basic principles of fairness had been bypassed, and that mechanisms for conflict resolution were either non-existent or ineffectual. In addition, it appeared to some complainants that Ministries were not following their own guidelines.

It should be remembered firstly that the following allegations reflect the perceptions of some coastal residents and do not, for the purposes of this report, reflect findings of fact by the Office of the Ombudsman. Secondly, the volume of complaints relative to the total number of aquaculture tenures, while significant to this office, is low. The number of new complaints has further declined, indicating perhaps the successful implementation of recommendations from the Gillespie inquiry.

Several examples of typical complaints follow:

- (a) Residents living in the same bay as a proposed fish farm made extensive representations to both federal and provincial authorities as to the environmental inappropriateness of a fish farm in that particular location. They argued that depth and tidal flushing were inadequate to ensure that disease would not be transferred from cultured fish stock to nearby shell fish beds. Aesthetic considerations were also advanced, as well as recreational concerns due to a perceived degradation of local water quality - i.e. the residents no longer wished to swim in the waters adjoining their homes. They didn't like their access impeded, their views altered, or their peace disturbed. Despite considerable protest

before, during, and after issuance of tenure, approval was granted for the fish farm to commence operations.

- (b) An individual who owned waterfront property with a spectacular coastal vista awoke one morning to find salmon farm net-pens anchored off the shore of adjacent property. The individual was taken completely by surprise and resented the fact that the fish farm tenure application had been "fast-tracked" to allow commencement of operations, with little or no perceived public involvement. In spite of considerable protest after the arrival of the farm, the Ministry of Forests and Lands subsequently issued a long-term lease for operation of the facilities at that location.
- (c) Application was made for a tenure in a sheltered bay of a small island community. Residents opposed the application on the basis that navigational safety and access would be impaired, there would be adverse environmental impact consequences, and coastal aesthetics would be harmed. There was also a general perception that the public involvement in the licence application process was not meaningful but was mere "window dressing" in that a decision to issue the tenure had been made regardless of local opposition.

More specifically, complainant perceptions and concerns can be grouped as follows:

(a) The land allocation process:

- lack of a clear publication of Ministry procedures and requirements;
- lack of a statutory framework clearly related to the subject of aquaculture;
- an "uncertain" referral process, with lack of meaningful participation by the parties to whom applications were referred for comment;
- the lack of a fair and effective appeal process;
- "fast-tracking", with no tangible observance of due process and a yielding to external pressures from "vested interests";

- lack of effective public notice of application for tenure and inadequate lead time for community planning and response;
- speculation in site acquisition could occur, whereby aquaculture operators would "tie up" a site with net-pen facilities for appearance purposes only, the ultimate purpose being to turn the site over at a profit to larger aquaculture firms.

(b) Environmental impact:

- adverse impact on aesthetics of the coastal environment;
- adverse impact on residential property values through alteration of the character of the coastline from wilderness to industrial;
- adverse impact on seabed marine life (non-motile organisms and flora);
- disruption of ecology: certain aquatic life forms might be removed or destroyed, while others might be attracted as predators to the salmon net-pens;
- perceived adverse impact of uneaten or excess fish feed and fish feces covering the seabed, and a general concern for the period of time necessary for sub-aquatic lands to recover to their former state;
- human waste disposal on self-contained "floating farms" (i.e. residential facilities attached to floating net-pens), and disposal of dead fish ("morts");
- lack of adequate regulation either to monitor or to control environmental impact by fish farms; and no appeal process by which affected parties can have their concerns adjudicated by an impartial, expert tribunal;
- the adverse impact of metal-based anti-foulant agents used on salmon nets to discourage marine plant growth on the nets.

(c) Conflict resolution:

- lack of any effective, or meaningful appeal process;
- lack of any mechanism for effective mediation or arbitration of individual and community concerns relative to aquaculture facility applications.

(d) Health considerations:

- effluent impact and water quality;
- possible intrusion of antibiotics into the food chain;
- a concern that farmed fish should be identified as such at the point of sale.

P A R T I I

PRINCIPLES OF ADMINISTRATIVE FAIRNESS
APPLICABLE TO LAND AND RESOURCE ALLOCATION,
AND CONFLICT RESOLUTION

PRINCIPLES OF ADMINISTRATIVE FAIRNESS APPLICABLE TO LAND AND RESOURCE ALLOCATION, AND CONFLICT RESOLUTION

In the annual and public reports produced by this office, the common goal has been to articulate the core elements of fair administration. It is appropriate to review these basic principles, as they will form the context within which the administration of aquaculture is reviewed and assessed in this report.

The following elements have been distilled from the experience and expertise of this office in matters of administration and are, in essence, foundational aspects of administrative law, with some specific modification appropriate to serve their application within the context of resource management and conflict resolution.

- (a) In matters affecting the rights and interests of Provincial residents, fairness, certainty, and predictability are best served through a legislative foundation by way of a specific statute, with enabling sections to provide for regulations.

Public trust and confidence in the regulation of an industry is best provided through the mechanism of a well-defined legal framework, especially in matters that may give rise to disputes among individuals with legitimate but competing interests. Where it is foreseeable that the rights of individuals and/or communities will be in conflict, the legal framework should be established by legislation, to which interested parties can refer in planning their affairs or resolving their disputes. Government performance and accountability then becomes measurable.

- (b) An opportunity for meaningful participation of those individuals or groups whose interests are affected, directly or indirectly.

Meaningful participation means that individuals, groups, local government, or any other party or parties with significant and legitimate interests will be recognized in the planning, implementation, and conflict resolution processes. It implies that their representations will receive careful consideration and will be accorded due regard consistent with the importance of the individual's interest. In other words, a duty is placed upon the

decision maker, insofar as is reasonably possible, to appreciate fully the significance of and the foundation for the various individual or group interests.

(c) A structured framework for the exercise of discretion.

The structuring of administrative discretion in decision making is essential to assure public confidence, and is most effectively achieved through the application of objective process and assessment criteria which are set out in legislation, regulations, and published official Ministry policy documents.

When administrative discretion is exercised in areas where potential conflict exists between private and industrial interests, there will always be suspicion that either the "vested interests" or the "squeaky wheels" have inordinately or improperly influenced the system for decision making. The publication of clearly defined criteria by which discretion is to be exercised, with clearly defined parameters such that similar situations are treated consistently and different situations are treated individually, is essential.

(d) Policy guidelines, rules and regulations promulgated by Ministries must be clearly defined in plain language and publicly available.

Public confidence is bolstered when the public knows and understands the decision-making process.

(e) Adequate and appropriate reasons for administrative decisions with significant impact should be provided in written form, whether required by law or not.

This enables parties to measure accurately performance against policy. Individuals are able to determine clearly the basis upon which the decision was reached, and are less likely to challenge the decision, particularly if the reasons provided make it clear that the available evidence was considered fairly. The decision thus made and articulated is also more likely to withstand later scrutiny by an independent review agency or tribunal.

(f) Internal review procedures that allow an affected individual to understand clearly the basis upon, or process by which the original decision was made, and to advance quickly and efficiently his

opposing views to an individual who has power to act, are useful and necessary to ensure that errors, such as incorrect or inappropriate interpretation of policy and regulatory requirements are either speedily rectified or openly justified to the satisfaction of all parties.

Whenever administrative decisions are made which are not consistent with the desires of parties who have legitimate interests, there exists the possibility of suspicion and resentment that the process was biased in favour of the party whose interests were apparently favoured. An effective internal review system in which individuals can participate and by which the rationale for a decision can be made known is the foundation for dispelling such suspicions.

- (q) External review procedures - appeals: an independent appeal process which is available without excessive cost is a vital aspect of assuring public confidence in the integrity of the regulatory process.

The appeal body should be expert in the technical area being administered, and as well should have at least one member well versed in the principles of administrative law. The appeal body must be truly independent with wide powers to hear evidence, call witnesses, and, if necessary, to substitute its decision for that of the administrative body in appropriate cases.

Section 59 of the Land Act is an example of an appeal system which is inadequate. The Minister appoints one of his internal staff members to hear the appeal if the Minister considers it advisable that the appeal be heard at all. An external appeal to court may be exercised only after the s. 59 appeal has been conducted, and on questions of law only. In other words, evidence may not be presented and reviewed on the merits at the "external appeal" in court.

- (h) An integrated, inter-disciplinary, and inter-ministerial planning process, based on a specific enabling statute and incorporating a long-range conception of the physical areas being administered or managed and which makes ample allowance for meaningful public participation at the beginning of the land allocation process, is basic to the achievement of administrative fairness; its application should extend not only

to maximizing benefits which may accrue from the development of a particular industry, but also to avoiding, rather than the more difficult and time-consuming resolving, of conflicts.

Before individuals and agencies can decide on the methods used to achieve certain goals, they have to decide where they want to be. This entails the creation of a long-range vision or concept. The translation of the vision into practical goals, objectives, and mechanisms for attracting public participation and dealing with public disputes, must be based on an overall framework for planning which respects diverse interests, mandates and expertise. Useful examples with practical emphases include: s. 90.58.020 of the Washington Shoreline Management Act of 1971, s. 302, Coastal Zone Management Act of 1972 (both found in Appendix 6); and "A Living River by the Door", documenting the proposed management system for the Fraser Estuary. Integrated planning allows each party to participate in the decisions which will affect its interests. In the case of industrial or commercial development in areas in which such development has previously been rare, the planning component becomes critical. The time period which may be allowed for publication of an application for Crown land, or even a public hearing, can be entirely inadequate for communities properly to address properly issues and concerns which will likely be manifested over the life of the industrial or commercial project. Since most developments of this nature are established with a long term private plan, so also should the local community be able to engage in long-term planning on a cooperative basis with provincial authorities. This will help to ensure that industrial developments on Crown land do not occur without the careful consideration that a planning process can provide, by way of sufficient lead time and a measure of informed anticipation.

- (i) An efficient mechanism for the independent assessment of environmental or social impact, in instances where the ability of the parties to make reasonable or accurate impact predictions is limited, and the magnitude of an unexpected adverse impact may be significant.

There may be instances where risks, minor to major, will be unavoidable, and a mechanism for securing information from a diverse range of interests will not be adequate in creating an information base for decision making sufficient to minimize risks. Where an error in siting of

an industrial facility could result in major injury to a fragile resource, (e.g., the location of a chemical processing plant relative to shellfish harvesting areas) a system of impact assessment which recognizes public interest and expertise as a valuable information source should be fostered. This is not formal conflict resolution, nor is it purely a planning matter. Rather, administratively fair systems of impact assessment should be directed at the unbiased acquisition of the best available data and predictions, which can then be applied to the critical questions of where, when, how, and whether or not to proceed with a project. Integral to the process and useful in enhancing the cost-effectiveness of the process, is the establishment of a threshold level at which a social or environmental impact assessment should be conducted.

The basic components of an environmental or social impact assessment which involves public participation may include, and should account for, the identification of the issue and determination of interests; the procedure for public notice and location and timetable of the proceedings; the style of hearing to be conducted; the access of parties to expert assistance, and their ability to obtain necessary relevant information. The sophistication of the parties for the type of hearing being conducted, and the procedure for appointment of the assessor or assessors are also important elements of such a process.¹⁰

A process to be avoided is the effect of experts retained to present data in a fashion which will advance only the interests of their client. Where such a presentation is made in a judicial (court) or quasi-judicial (administrative tribunal) environment, there remains the prospect that the best answer may be distilled from conflicting evidence; this is the heart of the adversarial system. A more satisfactory initial approach, consistent with an ultimate finding which is more likely to secure a lasting resolution, is contained within the concept of consensual dispute resolution. In its most basic form, the concept requires that opposing experts be required to create a consensus among themselves as to the accuracy of available data and areas in which legitimate questions remain, and an appropriate approach to the answering of those questions.

Any system of environmental or social impact assessment should be, as far as possible, time and cost efficient for all parties involved. If such assessments become a

barrier to participation then the ultimate goal of administrative fairness may be defeated; meritorious projects may be abandoned because the proponents cannot afford to risk inordinate expense in an application procedure, the results of which might be uncertain. Alternatively, opponents wishing to raise legitimate concerns and establish their case might not be able to finance the investigation necessary to produce the required evidence, and a potentially damaging development might proceed unchallenged.

P A R T I I I

INITIATIVES IN BRITISH COLUMBIA: A REVIEW AND
COMMENTARY ON CERTAIN RECOMMENDATIONS AND ACTIONS
RESULTING FROM "AN INQUIRY INTO FINFISH
AQUACULTURE IN BRITISH COLUMBIA".
(THE GILLESPIE REPORT)

THE GILLESPIE REPORT AND RESULTING INITIATIVES.

On October 31, 1986, a moratorium was imposed by the Honourable Jack J. Kempf, Minister of Forests and Lands, on the issuance of finfish aquaculture tenures. Six days later an inquiry into finfish aquaculture was established under the chairmanship of David Gillespie. Gillespie's mandate was to consult with government agencies, obtain public submissions from interested parties, and issue a report with recommendations to the Ministry of Forests and Lands within just 30 days. The moratorium was a result of concerns raised by the B.C. Fisherman and Allied Workers Union (UFAWU). The UFAWU called for a moratorium to allow for a full review of the impacts of the salmon farming industry, given the rapid increase in Crown land applications for finfish aquaculture during 1986. Four public meetings were held and 258 submissions (letters, formal briefs, and oral presentations at public meetings) were received.

The result of the enquiry was 52 recommendations. Recommendations touching on matters within the jurisdiction of this office are listed below, followed by a brief comment on government initiatives which have been effected to date. The sections of Gillespie's Report which have not been commented upon in this Report deal with matters which are exclusively technical or legislative in nature, and hence not appropriate for comment by the Ombudsman's Office.

Gillespie's Recommendations: Excerpts and Commentary

1. (Recommendation No. 4.1.2) "The government should develop a provincial aquaculture policy where it clarifies provincial direction, agency roles, and the responsibilities of both government and the private sector for the industry".

Comment: Gillespie views "...the lack of a strong provincial statement...as detrimental to the orderly and efficient growth of the industry". This observation is accurate and incisive. A strong, clear statement of policy is indeed necessary; however, it is the opinion of this office that it is appropriate for such policy to find expression in legislation. There are virtually no Provincial statutes or regulations which have been created in direct response to the growth of the industry. This has created a situation in which anyone wishing to

establish a fish farm, or object to a fish farm, must contact the appropriate Ministry, which may in fact have control over only one aspect of the farming operation, to find out what the government policy is. No formal and binding appeal system exists to provide a remedy for grievances of any of the parties involved in the process.

2. (Recommendation No. 4.1.3) "The government should establish an Aquaculture Advisory Council from key agencies and interest groups." This advisory council was established in mid-1987. Gillespie proposed that the council be the vehicle for direct involvement of the industry - he believes this is critical for development of aquaculture - as well as providing the opportunity for other interested groups (commercial fisheries, Native Indians, recreational groups and Fisheries Council of B.C.) to participate in the development of government policy.

Comment: This recommendation is an important step in the right direction, and has been fully implemented; the Advisory Council has been established and meets periodically to discuss issues of concern to its members, who represent a varied cross-section of coastal society, from fish farmers to local government to environmentalists. However, the non-binding recommendations of the Council will likely be inadequate to achieve the same degree of administrative fairness as an Act which is the product of public debate with specialized submissions, published regulations, and a binding appeal mechanism such as an aquaculture appeal board. An Aquaculture Steering Committee has been in existence since 1985, and exists to coordinate aquaculture policy, research priorities, planning and procedures among the various interested Ministries. Further comment on the Steering Committee is contained in Part V of this Report.

3. (Recommendation No. 4.1.6) "The government should support greater cooperation with local government in promotion, planning and approval of finfish aquaculture."

Comment: Gillespie notes that some local governments, caught in the middle between the industry and local residents who object to the presence of a fish farm, are unable to direct the proposal to more socially acceptable locations, while some other local governments are eager to attract the economic benefits of fish farming. Gillespie suggests that such provincial cooperation should include funding for promotion and planning of aquaculture, provision of model by-laws, and participation by provincial resource agencies in local planning. The mechanisms of zoning by-laws are only effective in providing a significant measure of involvement and local government control in the referral and approval process if they precede aquaculture development. This is because aquaculture operations will qualify as non-conforming uses if they are granted tenure before such local regulations are in place. Many operations were established before local controls were in effect.

4. (Recommendation No. 4.2.1) "The government should expand its public information programs to provide a broader range of services and information access."

Comment: This is an important proposal. However, this would be most effective in promoting administrative fairness if it was combined with a published Act and regulations to which individuals, industry members, and interested parties could be directed in response to their question, "Isn't there a law governing this?"

5. (Recommendation No. 4.5.2) "The provincial government should establish a mandatory environmental monitoring and data gathering system for each aquaculture site and surrounding area, the results of which should be submitted on a regular basis for review of changes in environmental quality."

Comment: Gillespie states, "Environmental monitoring represents a major deficiency in the regulation of finfish aquaculture". The government has taken steps to initiate such a program which will likely be established some time in 1988 under new regulations passed pursuant to the Waste Management Act. In the

interim, voluntary monitoring is being encouraged. Draft regulations were circulated in July, 1987 which exempt aquaculture operations from having to obtain a permit or approval under the Waste Management Act as long as requirements of the regulations for disposal of waste and provision of information to the Ministry of Environment are met. However, the onus is apparently on the Ministry to make investigations and demand samples to determine whether the aquaculture operation is causing pollution. There is a duty on the fish farm operator to report "a deposit of a substance causing pollution at the site of the operation" and to take appropriate action. This vaguely worded section would provide a doubtful basis upon which to initiate a prosecution or terminate an aquaculture lease or licence.

More recently, "Draft Environmental Guidelines for Marine Fish Farms and Ancillary Operations" were produced by the Ministry of Environment through the joint efforts of personnel in Waste Management, Water Management, and Planning and Assessment branches. These guidelines form the framework within which amendments to the Waste Management Regulation will be produced. The guidelines are being assessed and refined through an inter-ministerial referral process. This office notes the potential concerns in commenting upon internal documents not yet intended for public distribution, and which have a complex technical component. Therefore, it is appropriate at this time to limit any observations to a review of the elements which this office would consider useful as components of the Waste Management Regulation. Of necessity, some of these elements are presented in the form of questions, due to their inherently technical nature. They include:

- (a) What is the fairest and most effective method for determining which aquaculture facilities should require a Waste Management permit? If a numerical limit such as fish inventory, number of net-pens, or feed tonnage is used to establish a permit requirement, can the limit be avoided through restructuring of facilities or operations?

- (b) How will enforcement be effected? If termination of tenure is to employed as a sanction, will a determination by one Ministry (e.g. Environment) be binding on another Ministry (e.g. Crown Lands) which holds the effective power to carry out the sanction? What mechanism can be employed to resolve multi-party disagreements over technical issues? It is conceivable that two or more Ministries, the net-pen operator, and neighbouring landowners could all be at odds over the nature and impact of an alleged discharge from a fish farm.
- (c) If a waste management permit is not issued (i.e. not required) for a specific facility, what avenue will be available to adjoining or downstream shore residents to prevent a net-pen operator from causing, in the residents' view, fouling or pollution of the water surface or shoreline? An appeal to the Environmental Appeal Board is available at present only in instances where a waste management permit has been applied for or issued to the net-pen operator. While the Waste Management Act affords branch personnel wide powers to investigate and control activities causing pollution, any action to be taken remains solely within administrative discretion; no impartial review of the circumstances is available to affected parties, other than the rather costly and lengthy alternative of a court action.
- (d) What level of analysis is appropriate when impacts of proposed aquaculture developments are being assessed? Is review of the Marine Fish Farm Development Plan adequate? Is the assessment of a proposed site for "biophysical suitability" equivalent to performing an evaluation of probable environmental impact, or is it aimed simply at determining capacity of the site to sustain net-pen facilities over the long term? Can environmental impact assessment mechanisms be created and applied without inordinate expense or delay? (i.e. can assessments be carried out within the normal time frame required for approval of tenure, or within a reasonable period beyond?) Will public participation be recognized in an impact assessment process?

This office notes the thorough and excellent work undertaken by the Ministry of Environment in preparing new waste management regulations for fish farms. The intent of the previous four paragraphs has been to articulate fairness concerns as they relate to matters of public confidence and public involvement in the development of administrative systems for the governance of the aquaculture industry.

It is the opinion of this office that public involvement in environmental impact monitoring or evaluation, through an independent appeal process, promotes high standards of administrative fairness in the management of the shore zone, which may be appropriately regarded as a common public resource. In addition, a cost-effective system for environmental impact assessment benefits not only resource managers but the aquaculture industry as well, through optimum site selection; public opposition to fish farm operations should also decline if the requirements for environmental assessment and monitoring can be seen to be both rigorous and reviewable.

It is worth noting that officials of the Washington State Department of Ecology are nearing completion of a programmatic environmental impact statement which should significantly reduce the time and expense of measuring the potential consequences of proposed fish farm operations. (See Part IV (F) later in this Report)

6. (Recommendation No. 4.5.4) "The government should continue the use of a distance guideline to separate fish farms, and should apply this guideline to separate fish farms from shell fish aquaculture operations."

Comment: This recommendation has been adopted by the government and a distance guideline has been established at 3 kilometres between farms, up from the previous .918 kilometres (.5 nautical miles). Gillespie states that any decision to reduce this distance should be based on specific site factors.

Spacing of fish farms relative to residential settlements or biologically sensitive areas is another matter in which legislated avenues for public or expert involvement, and an independent appeal process, would be useful in securing administrative fairness to the benefit of local governments, land owners, and the aquaculture industry.

7. (Recommendations No. 4.6.1 to No. 4.6.6) Gillespie recommended a coastal resource identification study (CRIS) be carried out in a number of areas with utmost speed. This has been accomplished in the desired time frame, with a commendable and concerted effort by members of the Ministry of Forests and Lands, as it was then known. The Ministry has released its findings in the form of maps with the subheading "Aquaculture Opportunities". A number of agencies, communities, and special interest groups were apparently consulted in the preparation of the CRIS, and invited to submit mapped information with statements outlining their preferences as to locations where aquaculture development should be restricted or prohibited. CRIS was therefore designed primarily to determine where aquaculture should not go; thus, it serves as a conflict avoidance mechanism but cannot provide a comprehensive foundation for aquaculture planning.

In recommendations 4.6.1 to 4.6.6 Gillespie also recommends the discontinuation of issuance of aquaculture tenures adjacent to provincial parks and recreation areas, and further says that local government should be encouraged to develop or refine local zoning by-laws to address finfish aquaculture operations within their boundaries. These recommendations are reasonable; nonetheless one keeps returning to the central theme from the standpoint of administrative fairness, namely, the potentially uncertain nature of government policy, for which exemptions can be created through ministerial prerogative, as compared to a disciplined system of statute-based regulations which would provide a mechanism for case-by-case appeal.

As to the question of aquaculture regulation by local government, the Ministry of Agriculture and Fisheries' pamphlet "Fish Farming: B.C.'s New

Venture on the Coast" states, "...but it is at the local level that public input has its biggest impact...public hearings are required before any official community plan or zoning by-law can be adopted or amended". Persons opposed to fish farms can, "...as with any use of Crown land,...write directly with their concerns to the Ministry of Forests and Lands, Lands Division". Several problems become apparent when one considers this approach to dispute resolution and the powers of local government:

- (a) A public hearing is not the same as an appeal to an independent body; local public hearings address matters of planning and zoning but, as stated earlier, these must precede aquaculture development to be effective. They do not exercise power retroactively, unlike an appeal tribunal;
- (b) One's democratic right of writing to the Minister or to any ministerial official is not the same as a right of appeal. A Ministry cannot be expected to act as arbiter of an appeal of its own decision;
- (c) The Ministry goes on to say in the previously mentioned pamphlet that, "...noise, unsightliness, garbage disposal, and other community nuisance factors that could be associated with a fish farm are matters that may be subject to regulation by local government".

While the local governments may have jurisdiction in these areas, fish farms appear to be operational anomalies over which, because of overlapping jurisdictions by a variety of federal and provincial agencies, it is difficult for any one body to regulate specific impacts.

- 8. (Recommendations No. 4.7.1 to No. 4.7.5) On the subject of referrals and advertising in the aquaculture tenure approval system, Gillespie recommended continued use of the inter-agency referral system as a primary tool for conflict resolution. He also recommended that the government expand its lists of referral groups, increase the time available for response,

establish subsequent notification practices for referrals, establish an agreement with federal agencies respecting siting of tenures, information requirements, documentation of concerns, and importance given to referral comments. Also recommended was that the provincial Lands agency review its practices involving advertising and notification for prospective finfish aquaculture operations, and place greater emphasis on local government involvement to the finfish aquaculture referral process.

Comment: All of these recommendations are logical and would tend, if fully implemented, to increase the prospects for administrative fairness within the present system. The primary question is, however, whether the present system of an inter-agency referral process is inherently fair.

There is the risk that, by the time a user conflict surfaces, the parties who effectively possess either the influence or the power will be committed to a certain course of action. Indeed, Gillespie states (Recommendation No. 4.7.1), "...within areas where coastal resource identification studies are in place, it will be more appropriate to give greater weight to referral comments dealing with environmental characteristics of proposed sites and special management considerations rather than user conflicts". Such a statement presumes that identification studies and conflict resolution mechanisms will be utilized in a manner which reflect high standards of administrative fairness. This may be an unwarranted assumption given that good intentions and honest, competent efforts by Ministry personnel are sometimes inadequate in producing a decision-making process which is demonstrably fair.

9. (Recommendation No. 4.9.4) The provincial government should review and expand its legal tenure documents for finfish aquaculture.

Comment: Gillespie suggests that such items as mandatory site monitoring and reporting, aesthetic and visual standards and demarkation of tenure area be incorporated into the legal tenure

documents. This is an excellent and logical recommendation. However, by Ministerial directive any requirement can be deleted from a form; likewise, even if the requirements remain standardized, by Ministerial prerogative an application can be allowed, notwithstanding that certain established criteria may not be met in that specific instance. Greater certainty is provided when forms are prescribed by regulations created pursuant to statute; the process itself requires publication, and, in the case of statutes, an opportunity for public debate.

10. (Recommendation No. 4.10.1) "The present provincial agency approval framework should be maintained." Gillespie goes on to say that "...establishment of a 'single window' agency [which is apparently desired by the industry] would, unless accompanied by a major legislative overhaul, result in one additional level of contact, further time requirements, and major staff reallocation. "To be effective, the single window agency would have to be a neutral, rather than an advocate agency. The consolidation of legislative requirements affecting aquaculture siting and approval (e.g. an Aquaculture Act) would create anomalies and inconsistencies among remaining programs of the affected agencies". (emphasis added).

Comment: Mr. Gillespie's arguments against a single window agency may also be treated as eloquent arguments in favour of statutory regulation. Such a framework is necessary to maintain public confidence in an area where it may be seen that individuals with influence might be ignoring the rights of certain individuals or communities with legitimate interests. As the industry grows it is conceivable that the situation might worsen, given the economic advantages of utilizing economies of scale (large or multiple sites) near populated areas, which are often the scenes of greater user conflicts.

Gillespie is correct when he says that the single window agency would have to be a neutral rather than an advocate agency, as it would have the formidable task of being the "central switchboard" for a number of conflicting or competing interests. However, this would not

prevent Ministries such as Agriculture and Fisheries, or Regional Development, from engaging in promotional efforts and programs. A neutral agency, with published statutory standards, and an appeal mechanism would provide the authority that is needed for government to administer tenures and be held accountable on a case-by-case basis, as well as provide the flexibility that will be needed, given the reality that no two aquaculture operations and environmental circumstances are ever entirely the same. If such a system were to be put in place, then recommendation 4.10.2, that the role of the Ministry of Agriculture and Fisheries as lead provincial agency be clarified and focused, may become redundant. The only "lead agency" would be the Ministry or Board designated by statute.

Implementation of the recommendations of the Gillespie inquiry has been swift and comprehensive. Indeed, for the most part, the recommendations have been accepted without resistance and applied verbatim, resulting in significant improvements to the process. Policies of the Ministry of Crown Lands respecting applications for tenure, and the tenure documents themselves, have been reviewed, revised and expanded to incorporate the Gillespie recommendations. However, this cooperative action by various Ministries, undertaken in the utmost good faith, does not alter or alleviate the additional concerns of this office expressed both in the foregoing commentary on the Gillespie recommendations, and in the recommendations contained in this paper.

P A R T I V

AQUACULTURE IN OTHER JURISDICTIONS -
A BRIEF REVIEW WITH OBSERVATIONS
RELATIVE TO THE BRITISH COLUMBIA EXPERIENCE:

NOVA SCOTIA

NEWFOUNDLAND

NEW BRUNSWICK

SWEDEN

NORWAY

WASHINGTON STATE

ALASKA

OREGON

HAWAII

COMMENTARY ON THE U.S. EXPERIENCE

A SUMMARY REVIEW OF THE REGULATION OF AQUACULTURE IN OTHER JURISDICTIONS

To appreciate the challenge facing Ministry personnel in their task of regulating a new industry with complex social and environmental conflicts, it is appropriate and useful to look to other provinces and countries to review their unique responses to marine aquaculture.

The Maritime provinces have taken the lead in the creation of legislation to govern the industry as far as their jurisdiction will permit. On the other side of the Atlantic, Norway and Sweden have proclaimed the importance of aquaculture as a commercial component of the social fabric of their coastal communities. On the Pacific side, the States of Alaska, Washington, and Oregon have all established coastal management systems worthy of study, especially for the manner in which local communities are given a powerful role in the planning and regulation of shorezone development. The presentation which follows is cursory; references for further inquiry are provided in the bibliography.

A. Nova Scotia: SUMMARY AND ANALYSIS OF THE NOVA SCOTIA AQUACULTURE ACT (1983)

The following commentary contains verbatim excerpts which are for the most part self-explanatory. Only the major components of the Act are addressed, in order to provide a foundation for comparison with other regulatory regimes.

The primary function of the Act is to protect aquaculture operations from harmful pollutants. This is set out in plain language in the objects and purposes section of the Act, which purports to encourage and promote aquaculture by:

- i) Providing an environment in which aquaculture may flourish;
- ii) establishing the quality of water so that maximum aquacultural produce may be harvested; and
- iii) providing those persons engaged in aquaculture with a property right in the area licensed or leased and in the aquacultural produce being cultivated.

The Governor in Council may make regulations which include designating aquaculture development areas, imposing conditions and restrictions on the conduct of aquaculture or other activities in an aquaculture development area, and establishing water quality standards for water shed areas draining into an aquaculture development area.

Consultation with five related and relevant ministries is required before the Minister establishes an aquaculture development area; consultation with boards, agencies and commissions is required as prescribed. In addition, notice of the intended action is to be given and provision made for public hearings, advisory committees, or other vehicles for the expression of public opinion regarding the proposed designation.

The Ministry of Fisheries is the lead agency, and the official who conducts the public hearings is an appointee of the Minister of Fisheries.

Notice of the intended action and details on the public hearing are required to be published in a daily and weekly newspaper, if any, circulating in the municipality containing or adjacent to the area affected.

The Act requires the Minister to do a baseline study of deleterious substances in watershed and adjacent marine or brackish waters. A certificate of such substance levels is then produced and becomes prima facie evidence under the Act of the levels of such substances; the lease holder receives a copy of the certificate. The study forms the basis for later analysis of any pollution of the water, and for assembling the necessary evidence to invoke sanctions against the polluter.

An aquaculture licence from the Minister is the basic requirement; on Crown Land, an aquaculture lease is additionally required. The licence in an aquaculture development area carries with it the exclusive right to the use, for aquacultural purposes, of the water column and sub-aquatic land described in the licence. The licence or lease application requires all basic information to be disclosed concerning the nature of the operation and its technical requirements, as well as information on the quantity and source of fresh water, if any, required for the proposed operation, and the nature and extent of any deleterious substance expected to be deposited from the proposed operation, if any, and details of what measures are expected to be taken to reduce the deposit of these substances.

Aquaculture licences for private land are issued only to the owner or lessee of the land. In other words, there has to be a registrable interest in the land.

It should be noted that the Minister is not required to grant a licence. The licence may be terminated by the Minister at any time if false representations have been made in the application, or the holder of the licence does not show due diligence in fulfilling the terms and conditions of the licence.

The species of the aquatic flora and fauna for cultivation, its introduction, and feed stock flora and fauna are all subject to preliminary inspection by the aquaculture inspector, who has the authority to deny permission for use.

Escaping aquatic fauna remain the exclusive property of the licence or leasemaker while they are within 100 metres of the licenced or leased area boundaries.

The aquaculture inspector appointed by the Minister has full powers to enter and search aquaculture operations (except a dwelling) and make such tests and inquiries as may be relevant to the investigation. Every person responsible for an aquaculture operation is required to furnish information as requested by the inspector. Inspectors may also quarantine and destroy aquatic flora and fauna, seed stock or feed stock if it is infected with disease or parasites, or not authorized for introduction by an aquaculture licence or lease.

A registrar of aquaculture is also appointed, who is required to keep records and documents, which are open to public inspection, with the exception of such information as is provided to the registrar by the licensee or lessee, and in respect of which the licensee or lessee has asked the registrar to maintain confidentiality. (e.g. financial statements)

Comprehensive regulations may be promulgated pursuant to the Act.

With the emphasis of the Act on protection and promotion of aquaculture, and the water quality on which the fish farming operations depend, a question emerges: Could a fish farm degrade other waters or shorelines without suffering harm itself? This is a technical question within the jurisdiction - insofar as the question arises

in B.C. - of the Waste Management Branch of the Ministry of Environment. It is the opinion of this office that legislation which purports to protect water quality should provide that aquaculture operations be either protected or regulated, as appropriate, such that a farm fortunate enough to benefit from strong tidal flushing is not able to produce waste discharges with impunity, if the potential problem is simply transferred to another point on the shoreline. By the same principle, commercial fish farmers should be able to rely on timely administrative intervention to protect their operations from activities causing pollution damage.

B. Newfoundland

The Newfoundland Aquaculture Act, came into force on June 19, 1987. It is similar in substance to the Nova Scotia Act, with some significant differences:

1. The objects of the Act are slightly broader and more balanced in focus, in that reference is made to minimization of resource use conflicts and maximization of cooperative opportunities. The purposes of the Act are given as governing the conduct of aquaculture in Newfoundland in such a manner as to:
 - (a) Promote, in consultation with the private sector, the prudent and orderly development of an aquaculture industry;
 - (b) Secure the property rights of those carrying on aquaculture;
 - (c) Minimize conflicts with competing interests and uses; and
 - (d) Assist in consultative and cooperative decision making within the province and between the government of the province and the government of Canada.
2. The Minister has broad authority to incorporate into the licence terms of a development plan, standards relating to the utilization, stocking investment in, or production of, the aquaculture facility, and provision for access by continuous land owners through a site. Measures may also be directed to prevent the escape of aquatic animals and development and spread of disease and parasites, to minimize the risk of damage to the environment or other aquaculture facilities.

3. No aquatic plants or animals may be introduced into or transferred to a body of water or aquaculture facility unless the provisions of the Environmental Assessment Act have been complied with, meaning that the impact of introduction has been assessed in accordance with the Act. It should be noted that this provision may be bypassed if the Minister responsible for the Environmental Assessment Act determines that no risk is posed to the environment or natural stocks of aquatic plants or animals as a result of the introduction to the certain body of water or aquaculture facility. The Aquaculture Act requires that such a determination by the Minister responsible for the Environmental Assessment Act be based on an assumption that the plants or animals will escape into the surrounding environment.

Like the Nova Scotia Act, the Newfoundland Aquaculture Act provides for the establishment of an aquaculture registrar and registry, and an Aquaculture Inspector with broad powers of investigation and quarantine or destruction of stocks. Broad powers are given to the Minister for establishing regulations to govern effectively the conduct of the industry. These regulations may be established "respecting methods of handling, buying, selling, holding in possession, offering or advertising for sale, processing and maintaining the quality of aquatic plants or animals". This regulation would presumably allow the Minister to require farmed fish to be designated as such for the information of consumers at the point of sale.

Section 7 of the Aquaculture Act requires every licensee to report forthwith to the Minister or an aquaculture inspector any outbreak of disease or parasites. Like the Nova Scotia Act, the Newfoundland Aquaculture Act clearly establishes property rights in the cultured plant or animal product while it is in the possession of the licensee, and as well if the fish escape to within 100 metres of the leased site boundaries.

The manner in which any public input shall be received by the Minister for the purpose of assisting in decisions as to whether to grant an aquaculture licence may be determined by regulation. This does not require the Minister to engage in public consultation or hold public hearings unless the Minister deems such a procedure to be advisable and institutes the procedure by way of regulation.

Due to the fact that the legal framework for aquatic lands in Newfoundland is similar to that for aquatic lands on the coast of British Columbia, a lease of the water column and the seabed for the purpose of laying down anchors for the netpen facilities is required from the Department of Forest Resources and Lands. Because of the overlapping jurisdiction in coastal lands (as previously described), the Department of Forest Resources and Lands sends applications to the Aquaculture Registrar of the Department of Fisheries. The registrar then initiates a referral process to the Federal Department of Fisheries, Federal Ministry of the Environment, and the Coast Guard.

It should be noted that one apparent deficiency of the land allocation and aquaculture licence scheme in Newfoundland is reflected in the lack of an effective independent appeal system in either legislation, regulations, or official policy.

C. New Brunswick

On May 17, 1988, the Honourable Douglas Young, Minister of Fisheries and Aquaculture, introduced for first reading Bill 63, the Aquaculture Act, in the New Brunswick legislature. Some excerpts from his introductory statement are noted below:

"The Act recognizes that the future of aquaculture development must be orderly so that boom-and-bust expansion does not occur and leave people out of work a few years from now. Failure to approach the industry with a rational development strategy will jeopardize the long-term viability of aquaculture in New Brunswick, as has often been the case in other jurisdictions.

The Act sets down the legal authority of the Minister of Fisheries and Aquaculture to promote, regulate and manage all aspects of the industry from the backyard to the marine culture of salmon, other finfish and shellfish from fresh-water hatcheries to nutrition and harvesting of aquaculture products.

...The Act sets the framework for encouraging an industry where sound management practices ensure minimal losses and minimal interference with traditional fisheries and other affected interest groups.

...The public consultation process which will occur over the summer months is an important opportunity for the public to become involved in the formation of this Act. If the public identifies major changes that are required, those changes will be made before the Act is proclaimed. Those who participate in the public consultation process will be contributing to the final draft of the legislation and will obviously have an impact on its rules and regulations."

It is conceivable that the proposed Aquaculture Act of New Brunswick may undergo significant revision as it moves toward 3rd reading and proclamation. However, in its present form it appears to represent a solid attempt to synthesize the best elements of aquaculture legislation in New Brunswick's neighbouring provinces.

Some of the major elements of the Act are reviewed briefly below:

1. An Aquaculture licence is the basic requirement of the Act; a Registrar is appointed by the Minister of Fisheries and Aquaculture to issue licences in accordance with terms and conditions established by regulations passed pursuant to the Act.
2. The Registrar may impose conditions when issuing, amending, or renewing an aquaculture licence; the conditions mentioned in the proposed Act relate to adherence to aquaculture site development plans, site utilization, stocking densities, production, environmental degradation prevention, prevention of escape of live produce, disease or contaminant transmission prevention, and compliance with health, grade, and genetic standards for produce.
3. Inspectors may be appointed by the Minister to enforce provisions of the Act. An inspector under the Act has the powers of a peace officer.
4. The Registrar may suspend or revoke an Aquaculture licence as a result of false information supplied by an applicant or licensee, violation of provisions of the Act or a condition of the licence, or failure to exercise "due diligence" in fulfilling the terms and conditions of the licence or in complying with the Act.

5. Broad powers are granted to the Registrar to inspect facilities, demand records, take samples, and carry out tests of a licensee's aquaculture operation.
6. The Minister may designate land under his administration and control as aquaculture land and may lease such land for aquaculture for a period not to exceed ten years.

Comment: Such a provision would be difficult to enact in B.C. without binding the Minister of Crown Lands; the reason for this is that the B.C. counterpart of New Brunswick's Minister of Fisheries and Aquaculture, identified here as the Minister of Agriculture and Fisheries, has no direct control over the disposition of land tenures. While the Minister in B.C. may designate certain aquatic lands as suitable or unsuitable for aquaculture, the process by which a lease is acquired remains in B.C. within the jurisdiction of the Ministry of Crown Lands. The maximum lease period in B.C. at present is 30 years.

7. A decision of the Registrar may be appealed to the Minister, whose decision is final "except on the grounds of an excess of jurisdiction or a denial of natural justice". (Emphasis added.)

Comment: From an administrative law viewpoint this is an interesting provision, as one might argue that the Minister would inevitably be biased in favour of the Registrar's decision; bias is one ground upon which it may be asserted that natural justice in an appeal process has been denied. This concern may be alleviated in large measure through a progressive refinement of the appeal process by regulation. The power to establish regulations governing all aspects of the appeal process is specifically provided for in the Act.

8. The power of the Registrar to enforce compliance with key requirements of the Act (acquisition and display of licence, cultivation of specifically authorized plant or animal species, maintenance of records, provision of information, etc.) is bolstered through the penal sanctions of the New Brunswick Summary Convictions Act.

9. The Minister may, but is not required, to undertake public consultation and establish advisory committees with respect to aquaculture.
10. The Act provides for the establishment of regulations in no less than 38 separate situations, ranging from fees to genetic standards for "aquacultural produce". This appears to be a recognition of the fact that more knowledge and experience is required to properly regulate this new industry, and that the flexibility offered by regulations will be the key to progressive adaptation of the requirements set by government.

D. Sweden¹¹

Applications for authorization to conduct an aquaculture operation in Sweden are, in general, considered by two authorities:

- (a) County Administration, in accordance with the Environmental Protection Act, and
- (b) The Swedish National Board of Fisheries (with application made to the Regional Fisheries Office), in accordance with the provisions of the Fisheries Act.

The principal referrals conducted directly by the Regional Fishery Office are to the agency for occupational fishing, and to the agency for recreational fishing. It is apparent that the interests of both traditional fisherman and recreational anglers are accounted for in this referral. In addition, one of the final referrals obtained from the State Veterinary Institute. The principal function of the Swedish State Veterinary Institute is to prevent the spread of serious contagious fish diseases to the Swedish wild fish industry, and between individual fish farm sites.

The system undertaken by county administration in accordance with the provisions of the Environmental Protection Act is in broad form analogous to the referral system as it presently exists in British Columbia. The first referrals are to local government, the Coast Guard, and the shipping and navigation authority. The interests of the Coast Guard and shipping and navigation authority are, presumably, closely aligned and would be concerned

primarily with the preservation of safe navigable waterways. As the attached diagram (Appendix 4) illustrates, there are additional referrals which deal with environmental impact (nature conservation and environmental protection), site development (physical planning and building), surveying, regional economics, defense, and legal matters. The last three categories are perhaps unique to the Swedish situation. The Department of Regional Economics would provide information with reference to the appropriate siting of aquaculture facilities in order to maximize, and equalize, development along the coast of the country. The development and population of the coast is relevant to another unique referral category, defence. It is apparently the view of the Swedish government that a populated coastline which enjoys a degree of economic stability serves the interest of national security.

Lastly, a referral which deals with "legal matters" would ostensibly concern itself with the resolution of conflicts having to do with title or tenure to upland or aquatic lands needed for, or impacted by, a proposed aquaculture facility. These referrals are also provided for the Swedish National Board of Fisheries in its decision-making process.

Where there is "a risk that proposed aquaculture will transgress public or private rights", one of six Water Rights Courts in Sweden will conduct consultation with various administrative authorities including local, county administration, the Crown Land Judiciary Board, the Swedish National Board of Fisheries, the Swedish National Administration of Shipping and Navigation, the Swedish National Environmental Protection Board, and other appropriate agencies. In essence, the Water Rights Court is an administrative tribunal which carries out both administrative and quasi-judicial functions. It is an interesting model for dispute resolution or adjudication, and is preventative in that certain rights need not be transgressed before the jurisdiction of the Water Rights Court is invoked; a risk of transgression apparently is all that is required. Its efficacy may also be a product of Sweden's unitary system of government, in which the Canadian challenge of federal-provincial separation of powers is not an issue.

Appeals against decisions of the National Board of Fisheries, as well as county administrative boards, can be presented to the Swedish government. The precise details of the appeal procedure and the appellant body have not been researched by this office.

E. Norway

FISH FARMING, AND THE REGULATION OF THE INDUSTRY¹²

i) The Statutory Environment

The following comments relate to the provisions of Act No. 68 relating to the breeding of fish, shell fish, etc.

Section 1 sets out the purpose and rationale of the Act, which is economic in its orientation: "The Act is to contribute towards the balanced development of the fish breeding industry and to help it become a profitable and viable regional industry." The word regional is noteworthy because the allocation of licenses, dealt with later in the Act, is based in part upon regional considerations. The desire of the Norwegian government is apparently to promote a well-dispersed economic base for the development of coastal communities. This would maximize employment benefits, minimize localized environmental impact, and, as in Sweden, serve the security interests of the country through maintenance of a coastline with relatively equal population distribution.

Section 2 defines the scope of the Act; it is quite broad, encompassing the feeding and handling of fish and shellfish with a view to consumption, feed production, reproduction, release, research or education. Section 3 sets out the basic requirements: such activities are only to be done through benefit of a licence with specific restrictions as stated by the licence which would include the size of the operation, the species of fish or shell fish, and by certain ownership conditions. It is apparent by Section 6 that the government desires that the majority interest in the facility be held by several individuals or a juristic person [Company] with a local connection. This is consistent with the administrative requirements of the Land Act in British Columbia; it would not prevent offshore ownership but would require the creation of a legal entity on a local basis for the administration of the enterprise.

Section 5 sets out the "absolute conditions" for the granting of a licence, and these are divided into three categories:

- (a) Possibility of disease outbreak among neighbouring fish or shell fish;
- (b) pollution risk;

- (c) "unfortunate location" in relation to the "surrounding environment, lawful traffic or other exploitation of the area."

There are a number of noteworthy miscellaneous provisions in the Act. Among these is the right to re-catch fish which were formerly penned in but escape "in a free state in the vicinity of the facility." This right to re-catch may be exercised up to fourteen days after escape and may be effected with the assistance of equipment fastened on land.

The obligation to provide information is spelled out and is imposed on anyone who has or who applies for a licence: all information is to be provided as necessary to allow authorities to be able to perform their duties under the Act. The authorities have full access to the facilities at the place to which the Act applies, and have full investigative authority.

Section 11 allows authorities to withdraw a licence in the event that the aquaculture facility "causes or involves risk of causing substantial damage of the nature" (environmental impact).

In an attached commentary to the Act a number of observations are worth noting. First, the "absolute conditions" under which a licence is issued also put the onus on the facility to comply with provisions of the Fish Diseases Act, the Pollution Act, and the Harbours Act. The expression "distinctly unfortunate localization" is also identified as meaning not only harbour and navigational considerations administered by the National Coastal Administration, but reflects a process by which "due consideration shall also be shown to other established activity. In this connection, the term "established activity" may also include "fishing and gathering of seaweed." Environmental emphasis and "outdoor life" (presumably recreational, or tourism) must not suffer.

A recent amendment to the Act allows the government to make exceptions to statutory requirements in "extraordinary circumstances", and allows for the moving and temporary relocation of facilities.

The regional nature of the industry is emphasized in the commentary, and it is made evident that the granting of licences annually is performed by the Ministry of Fisheries to "help to ensure a reasonable geographical

distribution of the facilities throughout the country." Presumably, each coastal community is reasonably well served by an established road network. An absence of a road network serving the north coast of British Columbia would indicate that the wholesale importation of such a regional development concept would not be feasible, except through some form of incentive by which water or air transportation facilities could be established at reasonable cost.

ii) Administrative Issues Related to Licencing in Norway

It is noted that "the decision making process connected with each round of issues of licences is extremely cumbersome and takes a long time." The fact that licences are issued periodically in "rounds" (to allow for assessment of industry and community development as at a given date, and control numbers and dispersion of fish farms) reflects the Norwegian government's approach to aquaculture as an economic and social matter of national importance. Efforts are currently being undertaken to increase the effectiveness and rationality of the licence issuing procedure; in conjunction with this will be amendments to the Fish Breeding Act, with greater compliance being the chief goal.

The Norwegian Ministry of Environment has advised this office that, as at November of 1988, the government is preparing for the issuance of an "extraordinary round" of licences in the two northernmost counties in Norway, and special enabling regulations are being drafted with the purpose of encouraging economic activity and employment in that part of the country. In addition, regulations have been passed to streamline the licence issuing process and provide a greater role for the counties.

iii) Resource Use Conflicts, and Resource Planning in Norway, With Observations on the B.C. Experience

In Norway, the Planning and Building Act is seen as a potential avenue to resolve user conflicts "since the municipality is given the authority to reserve specific areas for different purposes, including aquaculture." However, recent experience has shown that this Act does not allow for extensive planning in the coastal zone. This office has been advised that there is now a proposal before the Norwegian Parliament suggesting an expansion of jurisdiction of the Act to provide for this type of planning.

Comment: This is analogous to the situation which currently exists in British Columbia although with less tightly defined legislative authority. In B.C., municipalities and regional districts have the right to zone the foreshore, including the water surface within their boundaries, for particular activities. While the province has the authority to override the expressed desires of local government and issue a licence, the licence is always issued subject to the requirements imposed by local governments. It is worth noting that the provincial ministries associated with aquaculture administration, particularly the Ministry of Crown Lands, respect the established desires of local governments expressed either through zoning or through the creation of an adopted official community plan, established pursuant to the provisions of Sections 944 to 949 of the Municipal Act. The problem which has existed and continues to challenge local governments is that issuance of licences may well occur within a time frame such that the regional district, Islands Trust, or municipality cannot produce an organized response. For the local government, such challenges require planning and foresight, and most often must be undertaken independent of any provincial initiative. By the time a licence is issued and an aquaculture netpen facility is floated into place, the creation of an official community plan or the designation through zoning of a specific area as not suited for aquaculture, is, with respect to that facility, of no practical effect. The commercial aquaculture facility is entitled by law to enjoy the use of its tenure, and to obtain such renewals of tenure as it is able, as a "non-conforming use" (Section 970, Municipal Act). In this respect, zoning and planning are effective only to control future development and can do little to affect development which has occurred previously.

Some communities in British Columbia have initiated or are participating in planning exercises aimed at effective and rational control of aquaculture siting and development. For example, residents of Cortes Island have developed a comprehensive set of policies dealing with coastal protection, economic development, public access, private property interests, and public participation in consideration and approval of applications for aquatic land tenures. These policies were submitted, pursuant to Section 951 of the Municipal Act to the Board of the Comox-Strathcona Regional District for consideration earlier this year. The process is ongoing at the time of publication of this Report.

Another example is the Sechelt Inlet Coastal Strategy Pilot Project, which the Foreshore Advisory Task Force of the Sunshine Coast Regional District has commissioned in order to obtain documented information on land status, land use, and land user and agency patterns of use and interest. This information will in turn lay a foundation for disciplined land use planning within the limits of the Regional District's jurisdiction. Financial support is being provided by a planning grant from the Ministry of Municipal Affairs.

At present there is a project in Norway which is loosely analogous to the coastal zone management schemes which have been developed in Washington and Alaska. The project is known as LENKA, a cooperative effort of the Ministry of Fisheries and the Ministry of Environment. LENKA is the acronym for the title: Nation-Wide Analysis of the Suitability of the Norwegian Coast for Aquaculture. LENKA has as its goal the provision of practical assistance to municipalities in the "planning of the coastal zone and water courses." This would include the development of a body of professional knowledge and advice for aquaculture planning and development in a way that recognizes the inter-relationship of environment, industry, conservation, and other interests such as recreation and public enjoyment. LENKA's first report is scheduled to be introduced in 1989.

It should be noted that the approach utilized in LENKA is not unknown to resource Ministries in British Columbia: Westwater Research Centre at U.B.C. provided a series of reports to the Marine Resources Branch (predecessor to the Aquaculture and Commercial Fisheries Branch of the Ministry of Agriculture and Fisheries) in 1982 and 1983. Resource conflicts in coastal land allocation were foreseen, and mechanisms to plan for conflict avoidance were proposed.

The Norwegian government recognizes that the effective resolution of coastal zone conflicts cannot be achieved in its entirety through "ordinary planning of the use of sea areas", and legislative amendments are being considered to cope effectively with the situation. It is the opinion of this office that a program of rational legislation produced with the assistance of maximum participation from all interested sources reflects an optimum means of achieving fair regulation in a complex area of inter-dependent interests. Regulation through administrative policy alone is inappropriate in that

superior interests can be recognized on an ad hoc basis, and the system itself can become the subject of much suspicion, resentment, and litigation.

F. Washington State

Broadly speaking, governance of the coastal areas of Washington State is carried out under two Acts: the Shoreline Management Act of 1971 (SMA), and the rules of the State Environmental Policy Act (SEPA). These two Acts operate in coordination with Federal legislation, the Coastal Zone Management Act of 1972 (CZMA).

The SMA of 1971 in its opening paragraph sets out clearly the State policy and use preference for shorelines of the State. The SMA provides substantive guidelines for the development of master programs by local governments. These programs are created by local government, with public hearings, in accordance with the criteria set out at the beginning of the SMA, regarding State policy and use preference. The master program is submitted for approval to the Washington State Department of Ecology which then reviews and may approve it in cooperation with the Federal Secretary of Commerce, who administers the grant program under the CZMA. The CZMA states that the Secretary of Commerce "may make grants to any coastal State for the purpose of administering that State's management program...[if]...the State has developed and adopted a management program for its coastal zone in accordance with rules and regulations promulgated by the Secretary, after notice, and with the opportunity of full participation by relevant Federal agencies, State agencies, local governments, regional organizations, port authorities, and other interested parties, public and private, which is adequate to carry out the purposes of this [legislation]." The Secretary may also make grants for the development of management programs, and for resource management improvement.

Once the master program is approved, the effective power shifts to the local government, in order that it may issue development permits and retain control over administration of its master program. Thus, permit decisions are made at the local level. Both the SMA and the SEPA process provide opportunity for public input in the decision making process. Appeals can be made by any interested party, such as local government, a State agency, or a concerned citizen, after the local government makes a permit decision. The State government has veto power over a development proposal only in cases where it strongly

disagrees with a development application which falls within the "Conditional Use or Variance" classification under State law. Approximately one-third of development permits come within this heading.

In addition, about 4% of the "substantial development permits" (the most commonly issued type of permit for shoreline development) granted by local governments are appealed to the Shoreline Hearings Board by the State. Opposition to aquaculture proposals in Washington has been most effective at the local level, where most permits are issued. Obviously, elected officials ignore public opposition at their peril. Some local governments have taken the step of calling moratoriums on net-pen development.

The system employs several elements fundamental to administrative fairness:

- (a) a clearly defined legislative base;
- (b) detailed structure for the exercise of discretion and maximization of public participation (through Shoreline Management Act guidelines for development of master programs, and legislated criteria for issuance of development permits on the shorelines of the State); and
- (c) an independent and binding appeal process, exercised through the Shorelines Hearing Board; in addition, a further appeal on the merits to the Court is available for any decision of the Board.

However, information received by this office suggests that all is not perfect with shoreline management in Washington, and the aquaculture industry in Washington is in a relatively embryonic state as a result. It has been suggested that some of the procedural hurdles built into the Shoreline Management Act, such as the authority of the Shorelines Hearing Board to order the production of an environmental impact statement, can be used effectively to block an aquaculture development proposal. Not only are environmental impact statements expensive for private corporations to procure, there remains the risk at the end of the day that their proposal will still be defeated. In the opinion of this office, if procedural hurdles can be used effectively to prevent an application from being heard on its merits without incurring prohibitive expense, then this may in itself constitute administrative

unfairness. The Department of Ecology in Washington is attempting to overcome this type of potential institutional barrier to development through the creation of a "programmatic environmental impact statement" (E.I.S.), which will streamline the impact prediction process through recognition of critical environmental variables, which can then be applied to standardized formulas for analysis. This office has been advised by officials in Washington State that the programmatic E.I.S. may reduce in scope, or eliminate entirely, the site-specific E.I.S. in cases where the basic site characteristics fall within the parameters of the programmatic model. It is anticipated that the programmatic E.I.S. will be officially adopted in the spring of 1989. (Similar criteria exist and are applied by Ministry personnel in B.C. on a lesser scale for determination of basic "biophysical suitability" of sites.)

A potential deficiency of the Washington regulatory model is the resolution of conflicts through a system which is in essence adversarial. The "litigation model" has so far been employed as the primary mechanism for conflict resolution in many American regulatory systems; only recently have the functional inadequacies of such a system been addressed. A significant and successful application of an alternate dispute resolution process is Washington's Timber, Fish, Wildlife Agreement, which was the culmination of an intense multi-party series of negotiations leading to the reconciliation of the interests of Native people, the forest industry, wildlife conservationists, and environmentalists, without resort to the courts. This process and the structure which underlies it is discussed later in Appendix 13. With respect to aquaculture, it would appear that the Washington coastal management system has so far been unsuccessful in reconciling competing interests. This in turn has given rise to certain initiatives, most notably reflected in an announcement from the office of the Governor, September 28, 1987:

"A State policy designed to promote the growing aquaculture industry in Washington while maintaining environmental safeguards was released today by Governor Booth Gardner. Gardner also announced that the State will hold an aquaculture conference in early 1988 to help "put all the issues on the table" and resolve controversies surrounding aquaculture development. "There has been some misinformation coming from a few people opposed to aquaculture development," Gardner

said. "It's time to get proponents and opponents together, separate fact from fiction and decide what the real issues are. Then we can move forward and manage the growth of this industry wisely with understanding and cooperation."

A senior official in the Washington Department of Ecology has informed this office that, to date, the initiative of the Governor's Office has not succeeded. Apparently the support of citizens and citizen's groups necessary for a consensual agreement to be formed was not forthcoming, as they perceived a bargained agreement to be inconsistent with their best interest. The system as it exists serves their needs more effectively. This makes an interesting contrast with aquaculture development in B.C. as it is perceived by some individuals, their view being that average citizens are powerless to halt an industry which enjoys government support.

Coastal aesthetics have proven to be an area of considerable concern in Washington. Coastal residents have made known their opposition to aquaculture installations which would visually alter in a significant way the character or ambience of the coastline. In an attempt to provide objective criteria to assess an otherwise subjective impact, the Department of Ecology in the State commissioned an "aquaculture siting study". The study utilized rather innovative methodology to predict visual impact and mitigate effects. There were four components to the visual impact analysis:

- (a) Computer simulations to demonstrate how different size facilities appear under a range of offshore distances and viewing heights;
- (b) photo simulations to portray accurately what a completed installation would look like;
- (c) visual impact assessment utilizing the main visual impact variables of landscape, viewer and facility (also included are two categories of mitigation measures, being alternate site selection, and facility layout and design); and,
- (d) a visual assessment workbook with an inventory component for rating the scenic quality of the site, number of viewers, and the visibility of the facility for resulting levels of potential visual impact is presented.

A cumulative impact analysis is also presented which incorporates not only the visual factor but biological, navigational, and access matters, for determining whether a threshold level suggesting alternative site selection has been reached. Some excerpts from the Aquaculture Siting Study and the visual impact analysis inventory and evaluation rating sheets are referred to in Appendix 5.

Selected excerpts from Washington State and federal coastal management statutes are included in Appendix 6.

G. Alaska

The Alaska Coastal Management Act consists of two separate statutory bases; Alaska statute 44.19 provides for the creation of an Alaska Coastal Policy Council and for the authority of the State Office of Management and Budget to render, on behalf of the State, consistency determinations and certifications authorized by the Federal Coastal Zone Management Act of 1972. Alaska statute 46.40 provides for the development of the Alaska Coastal Management Program, and, in a manner similar to the State policy enunciated in Washington's Shoreline Management Act, sets out the objectives of the coastal management program. This Act also gives authority to the Alaska Coastal Policy Council to identify and demarcate coastal resource districts, each of which is responsible for submitting an approvable district coastal management program which is consistent with the objectives outlined in the Act (s. 46.40.020).

Once the district coastal management program has been approved and is in place, the municipalities and state agencies are then obligated to administer land and water use regulations or controls in conformity with the program. An appeal to the council exists by which any district, citizen of the district, or state agency, may seek to enforce compliance with the provisions of the district coastal management program.

The Act also provides for the creation of coastal resource service areas, which are essentially vehicles for the provision of coastal management in sparsely populated areas; this is for the ultimate purpose of ensuring that no area of the coast is excluded from the benefits or protection conferred by the coastal management program.

The Alaska Coastal Management Program represents a model worthy of close scrutiny providing as it does a framework for local and public participation in State decisions, and a mechanism for the resolution of conflicts between government agencies, individuals, and local communities.

At the present time, salmon farming in net-pen facilities by private interests is not permitted in Alaska. The Alaskan State legislature passed a Bill (Chapter 145 SLA 88) which extended the existing finfish mariculture moratorium until mid-1990. However, the bill also legalized "sea vegetable farming" and established a regulatory scheme for this activity. It also established the "Alaska Finfish Farming Task Force".

Considerable controversy over proposals to allow such development continues. The State Legislature is considering the issue and the laws which would be introduced to govern the industry. Opposition to salmon farming in Alaska appears to have come primarily from the established wild salmon fishing industry, which is itself a major contributor to the State economy, and whose participants constitute a significant block of voters.

It is interesting to note that government agencies, academics, and lobbyists on both sides of the continuing debate in Alaska are studying B.C.'s experience with net-pen aquaculture very closely.

This office has reviewed with interest the final report of the "Etolin Island Area Mariculture Pilot Project". This report includes a comprehensive review of the biological and environmental issues associated with the aquatic farming of shellfish and marine plants. Excerpts from Chapter 3 of the report dealing with "Conflicts with other coastal users" and "Guidelines and Mitigating Measures", are attached for reference in Appendix 7.

Selected excerpts from Alaska State statutes are also included in Appendix 7.

H. Oregon

The Oregon State government describes its coastal management program in an explanatory text entitled "Oregon Coastal Management Program". The program summary which begins the text is reproduced in its entirety in Appendix 8 to this paper. Some additional excerpts from the text are useful in providing an overview of the system and the way in which it has been structured:

"The Oregon Coastal Management Program (OCMP) balances the needs for long-term growth, development, and protection of the State's coastal resources. Relying on a partnership among the public, local governments, and state

and federal agencies, the OCMP is based on separate but coordinated sets of planning and regulatory authorities:

- State wide planning goals adopted by the Land Conservation and Development Commission (LCDC);
- acknowledged comprehensive plans which local governments have developed and LCDC has approved; and,
- specified statutory authorities of various state agencies.

Together, these authorities establish policies and procedures for planning and managing the balanced preservation, conservation, use, development and restoration of the natural resources in Oregon's coastal zone.

These authorities are tied together by two requirements in Oregon's Land Use Planning Act and the State wide planning goals. First, the Act requires all units of government to coordinate their actions affecting land use with affected citizens and with local, state, and federal agencies. Second, the Act requires that the plans and actions of all agencies and local governments must comply with the State-wide planning goals and acknowledgement master plans."

Oregon's Coastal Management Program took shape early in the 1960s as economic, environmental and institutional concerns came to light:

"Accelerated growth on the coast was damaging fragile ecosystems; it also was aesthetically displeasing. Problems included the filling of estuaries, strip developments along coastal highways, draining of wetlands for development, and unplanned commercial and residential developments. In addition to private development, several state agencies were proposing or constructing projects which would significantly affect the natural environment of the coast."

The Oregon Coastal Conservation and Development Commission (OCCDC) was created in 1971 by the Oregon State Legislature to study these problems and propose solutions. It is interesting to note that the economic and environmental problems which OCCDC identified as facing the Oregon coast bear close similarities to the challenges which British Columbia now faces:

"The economy of the Oregon coast is characterized by over-specialization, persistent unemployment, low per capita income and a narrow tax base. These economic limitations are compounded by the highly seasonal nature of local employment and economic activities dominated by forestry, fishing, and tourism."

The Commission concluded that the problem was primarily one of inadequate management mechanisms. Again, there is a striking parallel with the situation as it currently exists in British Columbia. While there is no shortage among Provincial Ministries of either expertise, good intention, energy, or dedication, there are nonetheless significant administrative inadequacies which work to perpetuate the possibility of administrative unfairness through failure to reconcile, or put in place a management mechanism for the reconciliation of legitimate competing interests. For example:

OCCDC also found that a solution to these economic and environmental problems had generally been hampered by the fact that the governmental jurisdictions managing the coast did not adequately or effectively coordinate their activities. Limited financial resources and the need for effective citizen participation at all levels of government also required a cooperative and state-coordinated program to achieve wise use of coastal land and water resources.

By assignment from the Oregon State Legislature in 1975, LCDC acquired the task of completing development of the Coastal Management Program which had been initiated by OCCDC. Ultimately, four objectives were distilled for the Coastal Management Program:

1. Create and maintain a balance between conservation and development, and between conflicting public and private interests, that will assure the greatest benefits for this and succeeding generations of Oregonians;

2. Guide public and private uses of natural resources of the coastal zone to avoid irreversible damage;
3. Protect the unique character of life on the coast; and
4. Manage the natural resources and uses of the coast on an evolving and flexible basis so, as experience with and knowledge of the coastal zone increases, the program can be revised accordingly.

An appeal component has been built into the management program to respond to the controversy often accompanying land use decisions. This is the Land Use Board of Appeals (LUBA), which was created in 1979 and has jurisdiction over virtually all land use decisions; it has the authority to uphold, reverse, or remand (send back to authorities for reconsideration) a land use decision.

It is important to note that local governments are a pivotal component of Oregon's Land Use Program. Cities and counties are authorized by statute to adopt and implement comprehensive plans and zoning ordinances and to regulate land use within their jurisdiction; this authority is supplemented by State law which requires cities and counties to adopt or amend their comprehensive plans and implementing ordinances to comply with the State-wide planning goals.

These plans are the primary mechanism for establishing long-term, site-specific land use policies and decisions. They are also central to providing effective coordination among all levels of government. Once comprehensive plans are acknowledged, all land use decisions must be consistent with the plans.

As is the case in Washington, the Oregon Coastal Management Program mechanism for dispute resolution appears to be based on a litigation model rather than a consensual approach.

The OCMP explanatory text states, "An important hallmark of Oregon's Land Use Planning Program is its requirement that land use decisions include findings explaining how applicable ordinance standards have been complied with." This is an expression of the long established administrative law doctrine that, where quasi-judicial decisions are being made, reasons in support of the

decision should be given. The Oregon Supreme Court, in the case of Green vs. Hayward (1976) stated that "findings" to support land use decisions were necessary for the following reasons:

- (a) To facilitate judicial review;
- (b) To ensure more careful administrative consideration;
- (c) To help parties plan their cases for re-hearings and judicial review; and,
- (d) to keep agencies within their jurisdictions.

The Office of the Ombudsman is of the view that such a system is well-suited for the determination and declaration of legal rights or liabilities after a controversy has arisen. However, if various competing yet interdependent interests have not been reconciled in the planning process, it is doubtful that an adversarial appeal process would achieve such resolutions in many cases. A consensual approach in the first instance to the resolution of potential disputes involving the public interest would likely be more appropriate; this is discussed in detail later in Part VI of this report.

As a last note, Oregon has been included for study primarily due to its innovative coastal management systems. Net-pen facilities in Oregon are almost non-existent, due to the lack of sheltered, deep-water sites close to the shoreline. With its various estuaries, however, Oregon is well-suited for ocean ranching (defined earlier in this report) and has chosen to pursue this option for enhancement of fish production.

I. Hawaii

Hawaii is unique in having been the first State to carry out comprehensive resource planning and development for aquaculture. Pursuant to this, a natural resources assessment provided detailed data on potentially suitable sites, and a parallel study was conducted on aspects ancillary to successful industry development: technical resources, legal requirements, financing, marketing, and the like. These were ultimately, through experience, integrated into what authors Corbin and Young refer to as an "holistic conceptual approach, the Aquaculture Development Niche".

It is important to note that at present all aquaculture in Hawaii is land-based, and involves both fresh and saltwater facilities. The concept of ocean leasing, as the authors point out, poses a formidable challenge. Conflicts parallel those which have occurred in British Columbia, as shown by the following excerpt from the authors' paper presented at the Aquaculture International Conference in Vancouver (September, 1988):

"The process of establishing a new regulatory program for leasing of ocean space around the Islands illustrates another set of regulatory conflicts. Ocean leasing is a familiar concept, which allows ownership of ocean space for commercial use, such as mariculture. Examples of leasing abound worldwide; Hawaii is a latecomer to this area. Island interest began with a 1981 report which recommended the state consider ocean leasing for mariculture and other uses. A limited Ocean Leasing Act was promulgated in 1986, amid much controversy. The first test case, a tourist submarine company, was withdrawn.

Conflicts observed during the debate of the law and the recent test, stem from several fundamental issues:

- Private developers want long-term site tenure to justify the capital investment.
- Local interests do not want granting of exclusiveness to what has been traditionally a common property resource and cite aesthetic and environmental concerns.
- Ocean users, e.g. boaters, fishermen, divers, swimmers, and businesses fear interference and cite public safety concerns.

Resolution of these questions will await a future, probably non-mariculture test case. Fundamental problems to be addressed include lack of baseline environmental data, translation of complex environmental ideas to understandable language and strong emotionalism that prevails in these discussions. However, as with the discharge issue, the degree of difficulty in leasing will be very much dependent on the site chosen."

J. COMMENTARY: THE U.S. EXPERIENCE

Shore resource consultant Wolfe Bauer in a paper entitled, "The Geohydraulic system as a basis for shore management", presented to the shore management symposium in Victoria, 1978, made a number of useful observations based on his experiences in Oregon and Washington. A summary of his main points follows:

1. The Oregon legislature, in Bauer's view, properly put "the horse before the cart" in educating itself about coastal resources and priorities and preferences for resource use to control pollution and protect the environmental characteristics of the shore zone prior to creating management legislation and policy.
2. Oregon then conducted an extensive inventory of its coastline to determine the nature and extent of the resources there, to determine the types of physical ["geohydraulic"] processes at work shaping and influencing the shore area, and to classify the various areas of the "shore-process corridor" for management purposes.
3. Washington, in Bauer's opinion put "the cart before the horse" in designing legislation which divided shore areas into four categories (natural, conservancy, rural, and urban), "depending upon the degree of man's intrusion." Bauer's criticism of this approach is that it bears little relation to the natural processes at work in the areas being classified, and the boundaries between zones cannot be so neatly classified.
4. A common deficiency for both Oregon and Washington was noted:

While it was certainly more logical to first examine and define the shore resources as in the Oregon approach, delegation of this task to various unrelated agencies and consultants without insisting on a coordinating language or text proved to be a major weakness in consolidating all this information into a unified and practical management tool. In a similar way, the inability of the designated Washington State agency to provide over 50 local governments

and the citizen committees with a uniform technical language and education background to their riverine and marine shore systems resulted in a mish mash of inventories and classifications that was often more confusing than the Oregon inventory product.

5. In like manner, the systems in Oregon and Washington exhibited common strengths: "...it should be realized that the very act of providing a citizen-involved shore inventory program represents a new and promising direction of resource management in a democratic society. ...such legislation signifies a step in the right direction for, in broad terms, it recognizes the functional, recreational, economic, and aesthetic values of a shrinking resource heritage and addresses itself to the enhancement, preservation, conservation, and more informed and efficient use of all shore-related environments."

In the event that Mr. Bauer's comments with respect to Washington State sound too disparaging, Professor Robert L. Bish of the University of Victoria School of Public Administration notes in his book, "Governing Puget Sound", that by 1980 every local government except one on Puget Sound was operating a system under a state-approved master program. He went on to write (in 1982):

It is too soon and very difficult to evaluate the impact of the SMA on shorelines, but some decisions are notable. San Juan County has used its permit authority to reject proposals for recreational facilities on state owned land by both the Department of Natural Resources and the State Parks and Recreation Commission. In contrast, the City of Seattle has used its authority to encourage more public access to shorelines as a condition of permit issuance. It also appears that non-water dependent uses have been virtually eliminated.

This office does not advocate the wholesale importation of American coastal management structures for application within the B.C. context. Rather, as pointed out in each of the foregoing sections analyzing systems in Washington, Alaska, and Oregon, there are elements useful for analysis and possible incorporation to a model for integrated management of the coastal zone in British Columbia. Optimum fairness in the reconciliation of diverse

interests, all competing for a share of a finite resource, demands that a framework for public participation and goal-creation be established; that a legislative base be provided for the coastal management activities of both local and provincial authorities; and that mechanisms for appeal of adverse administrative decisions be put in place and made available to all affected parties - from small landowners to provincial Ministries.

P A R T V

- A. INTEGRATED RESOURCE MANAGEMENT: INFORMATION
EXCHANGE, PLANNING, AND ADMINISTRATIVE FAIRNESS

- B. SOME BRITISH COLUMBIA EXPERIENCES:
 - 1. GOVERNMENT RESEARCH AND RECOMMENDATIONS
 - 2. CROWN LAND PLANS
 - 3. THE FRASER RIVER ESTUARY STUDY

- C. INTEGRATED RESOURCE MANAGEMENT AND PLANNING:
SUMMARY

**A. INTEGRATED RESOURCE MANAGEMENT: INFORMATION EXCHANGE,
PLANNING, AND ADMINISTRATIVE FAIRNESS**

1. Aquaculture as a case study

It has been pointed out to this office by some individuals that there is little conceptual difference, insofar as land use planning and competition are concerned, between fish farming and many other coastal activities such as log storage, log booming, marinas, and pulpmill development. To the extent that aquatic land is occupied by a private party for an exclusive purpose, this is true. It is important to keep this fact in mind when reviewing the observations and recommendations of this office relating to planning and management of activities in the coastal zone.

The rapid development of the aquaculture industry over the last several years, and the anticipated continued growth of the industry fuelled by successful harvests and technological refinement, have provided to this office a useful case study in land and resource allocation. The conflicts which have arisen have in large measure been addressed through evolutionary changes in ministry policy; nonetheless, there are no guarantees that such conflicts will not arise again when economic demands for land and resources accelerate suddenly in a given geographic area. Anticipation and accommodation - more appropriately, reconciliation - of conflicting interests requires foresight, and foresight does not necessarily require the talents of a visionary; rather, it is the practical consequence of a disciplined and coordinated planning process which seeks out and explicitly recognizes the legitimate interests of all parties who may be affected by development - or, in some cases, a lack of development.

As set out in Part II (h) of this report, there is a fundamental relationship between planning and administrative fairness. This section will provide some discussion and examples of this principle in practice.

2. The primacy of planning

The fundamentals of planning are well understood within British Columbia's land allocation and administrative bureaucracy. Likewise, the province's universities and other educational institutions offer a well-spring of knowledge and original research in land use planning as a cornerstone of the concept of integrated resource management. American systems of coastal resource

management have been studied by both provincial ministries and educational institutions for at least the past ten years. Ministries with either major or peripheral involvement in aquaculture administration all recognize the importance of management tools which allow the left hand to know what the right hand is doing. This realization is reflected in the existence of what is known as the Aquaculture Steering Committee (ASC), formed in May, 1985.

The ASC, under leadership of the Deputy Minister of Agriculture and Fisheries, meets periodically to review and assess matters of concern related to aquaculture regulation and administration. These concerns span the entire spectrum of issues associated with the subject, ranging from municipal concerns to research projects aimed at helping the aquaculture industry combat fish disease. ASC exists because executive members of each of the Ministries involved realize the basic necessity to have, at the very least, periodic "round-table" discussions to exchange new information, decide Ministry priorities, coordinate programs, and attempt to work out resolutions to problems that cross jurisdictional boundaries.

The ASC is excellent in concept but faces a number of practical realities which limit its potential usefulness. These include:

- (a) There is no overriding legislation, regulation, or published policy which establishes goals, objectives or processes which the ASC must corporately pursue; rather, the ministries represented on the ASC continue to pursue individual legislated or policy mandates, and their representatives must, by reason of their positions, bring Ministry policy to the table.
- (c) A corollary of the above is that the ASC is dependent upon the goodwill and common sense of its members in order to achieve any degree of functional effectiveness. While the exposure of this office to the workings of the ASC indicate that these qualities are demonstrated in the ASC's deliberations, the process by which it operates and the jurisdictional division inherent in its composition do not ensure that the results of its work will serve the public interest in optimum fashion over the long run.

What remains obvious is that while each Ministry recognizes the importance of cooperative planning, and utilizes principles of "strategic planning" in the design and management of its own operations, integrated inter-ministerial planning does not exist under a broad legislative mandate.

3. Recognition of the primacy of planning: a review of the proposed Planning Act (1980)

In September of 1980, the Ministry of Municipal Affairs released a discussion paper containing the proposed Planning Act. The discussion paper begins with a detailed description of the need for planning and the mechanisms incorporated in the proposed Act designed to address this need. The principles enunciated reflect a solid understanding of the relationship between planning and administrative fairness, and are worthy of study. The proposed Planning Act failed to receive Cabinet approval and was never passed into law by the Provincial Legislature.

Some elements which are worth extracting from the discussion which preceded the text of the proposed Act follow. It should be noted for clarity that these principles and observations were extracted from the Ministry's commentary, and do not reflect an attempt by this office to analyze the text of the proposed Act itself. Observations and principles worth noting include:

- (a) Finite land resources and infinite land uses and requirements dictate the need for careful land use planning.
- (b) Planning necessarily demands regulation of activities, the most valuable activities being "evaluated on a scale of province-wide objectives and priorities."
- (c) Several statutes regulate land use, and compliance with their requirements may significantly increase the time, cost, and uncertainty associated with development.
- (d) A developer or other applicant or local resident deserves to know:
 - i) the reason for regulation and the process which must be followed;
 - ii) how long final approval will take

- iii) how many referrals are needed;
 - iv) who will consider the application at each stage of approval;
 - v) criteria for acceptance or rejection, and the values used to make a decision.
- (e) An efficient, inexpensive, and independent appeal system is necessary to correct instances of unequal treatment or incorrect decisions.
- (f) "Every citizen should be able to get an answer to the question of why the provincial government should be involved in any land use decision it regulates."
- (g) Local government should outline areas of its own need and concern, now and for the future, in land use plans which allow public participation in building a framework for regulation, and which enhance predictability of regulatory action and assessment of government performance.
- (h) Three administrative features of the proposed Planning Act which it purported to promote, and which would be endorsed in principle by this office include:
- i) A cohesive system of planning that is accessible and accountable at all levels of government, and,
 - ii) the coordination of provincial planning and land use programs to provide an integrated framework for determining the optimum use of land and resources.
 - iii) Approving officers in municipalities would eventually be "independent of any Ministry having a specialized interest in land use."

Some of the basic administrative principles enunciated in the proposed Planning Act are worthy of implementation in enabling legislation directed toward the establishment of integrated coastal resource management systems. It should be remembered at this point that aquaculture is and remains but one application of coastal resources.

B. INTEGRATED RESOURCE MANAGEMENT AND PLANNING:
OTHER BRITISH COLUMBIA EXPERIENCES

1. Government Research and Recommendations

In May 1977, the Coastal Zone Resource Sub-Committee, reporting to the B.C. Land Resources Steering Committee, produced a comprehensive work entitled "The Management of Coastal Resources in British Columbia". Volume 1 was produced in draft form only and was entitled "State of the Art". The "State of the Art": this volume contained a summary of recommendations, some of which are paraphrased below. It should be noted that the recommendations which follow were part of an internally generated document which was not officially adopted as an expression of government policy. Nonetheless, it is the opinion of this office that the administrative principles contained within the summary of recommendations remain equally applicable today, and it remains a valuable source document for anyone seeking to develop an appropriate system for the management of coastal resources in this province. It should also be noted that the Sub-Committee members were drawn from both federal and provincial ministries and represented an assembly of diverse expert knowledge.

Excerpts from the summary of recommendations of the sub-committee are reproduced in Appendix 11. The principal components of the sub-committee's recommendations are worth reviewing:

- i) A full-time inter-governmental agency mechanism should be established to perform coordinative, advisory, information, assessment, and identification functions regarding coastal management programs, strategies, and initiatives.

A major function of the agency mechanism would be development and implementation of an integrated coastal resource management program, beginning with the preparation of a coastal resource atlas and a "biophysical" inventory program for the coastal zone. Other related functions would include improvement of inter-agency information exchange, research programs, resource use criteria, and referral systems.

Public information and interdisciplinary resource management programs at the graduate student level would be encouraged as well as programs for generation of socio-economic information which would be integrated with biophysical data.

- ii) Initial focus for these initiatives would be in the Strait of Georgia region. [Note: The Committee likely reasoned that as the most populous coastal area of the Province, it would be the area of greatest environmental impact and potential resource use conflict. However, what was not foreseen at that time was the extensive development of Sechelt Inlet for aquaculture, and the controversy which has followed.]
- iii) Local governments should be assisted with application guidelines for biophysical and socio-economic data, and with technical expertise for zoning and development control process, as appropriate. General policy and management guidelines should be distributed to both government and private organizations involved in development of proposed facilities in the coastal zone.
- iv) Coastal resource management plans which designate the uses of land and water resources should be developed.
- v) Federal-provincial initiatives aimed at acquiring lands worthy of conservation, but not protectable through existing mechanisms, should be considered.
- vi) The public should have opportunities to participate in coastal resource use decisions, and "affected interests should be provided with an opportunity to participate directly in the decision-making process."

2. Crown Land Plans

In June 1980, the Skeena Region Operations Division of the Ministry of Lands, Parks and Housing, published the Graham Island Crown Land Plan. It was adopted at that date as official Ministry policy for "the planning, management and disposition of unalienated Crown lands in the Plan area."

It was a five year plan, binding upon the Ministry of Lands, Parks and Housing until July, 1985. In the Plan, the planning process, goals and objectives were all clearly laid out as well as the results of a physical inventory of the study area, including resources such as forestry, mineral and petroleum resources, agriculture, fish and wildlife, and archeological and historical sites. Present land use and resource capabilities were emphasized, and alternative development concepts (industrial, rural, or environmental) were put forth and evaluated. Finally, planned policies for each type of development or use were set out. It thus became a comprehensive information document and a reliable, predictable indicator of Crown policy for all of the lands within the study. The plan was not a paradigm of integrated coastal resource management, however, in that it dealt only with the use and disposition of Provincial Crown land. Integrated resource management as the concept is applied in this report refers to a process in which more diverse interests, and the use of lands over which other levels of government have jurisdiction, are recognized and reconciled to produce maximum benefit and minimum detriment to all parties.

Another useful example is the Sooke Harbour and Basin Crown Foreshore Plan released in August of 1980. This plan is similar in substance to the Graham Island Crown Land Plan, and involved the establishment of goals, the inventory of all resources and land uses within the study area, and the presentation of detailed plans and policies binding upon the Ministry of Lands, Parks and Housing for a five-year period. Detailed plans for specific areas, a "permitted use matrix", and a comprehensive plan map outlining development areas, resource management areas, and deferred planning areas, were included as integral components of the document. Nonetheless, what resulted was a Plan which reflected only the best efforts of one Ministry to serve the public interest to the limit of its own mandate. In that respect it did not fit within the overall concept of integrated resource management as it is understood by this office. A quote from the "Forward" to Sooke Harbour and Basin Crown Foreshore Plan will illustrate the limitations faced by the Ministry then known as Lands, Parks and Housing:

The pursuit by the Ministry of a planning process to facilitate improved Crown lands and foreshore allocation and management decision-making does not imply that the Ministry is attempting to usurp the planning and management

responsibilities of other government agencies at all levels. The Ministry recognizes and supports the fact that, by virtue of various statutes, many agencies have planning and management responsibilities relative to specific resources such as, for example, forests, water, wildlife, and archeological resources. The intent of the Ministry is to encourage these agencies to further their mandates to the greatest extent possible, as they pertain to unalienated Crown land and foreshore, and in a manner which maximizes the long-term economic, social and environmental benefits to the residents of British Columbia.

The Ministry could only rely on the goodwill and dedication to public service of the other Ministries to exercise their authority in a way which it was hoped would serve the best interests of all involved. In the absence of enabling legislation creating a statutory system of priorities, planning tools, and implementation mechanisms, an encouraging word was the best that it could offer. Other comprehensive Crown land plans, most notably involving estuary management, have been produced and implemented. A full analysis of their creation and operation is beyond the scope of this paper.

3. A Mighty Effort: The Fraser River Estuary Study. (FRES)

It is difficult to convey adequately the scope of effort and coordination which ultimately resulted in a management program for the Fraser River Estuary. It began as a joint federal-provincial study in 1977 by agreement between both federal and provincial ministries of the environment. Phase 1, which was completed in 1978, resulted in a series of reports describing characteristics of present and future land use and transportation; water quality, habitat, and recreation; and an analysis of the constitutional and legislative frameworks for estuary management.

Phase 2 of FRES was initiated in 1979 and completed in March of 1982. This included technical reports with proposals and data on management systems, information systems, area designation, referral systems, legal provisions and organizational options. Phase 2 also produced a comprehensive report on the results of public involvement and public opinion. The document containing the final proposal for an integrated management plan was entitled "A Living River by the Door".

The report of the proposed management program for the Fraser River Estuary is divided into five main segments: 1) Vision, 2) Creating a management program for the estuary, 3) Estuary management policies, 4) Estuary management system, 5) Estuary programs, plans and designations.

The elements of the management program and its relationships are illustrated by the diagram in Appendix 9. It begins with issues, concerns and trends in the changing estuary which are incorporated into visions for the estuary. Visions (or long-term concepts) are then translated into policies in which a basic policy is created with goals and objectives surrounding each of the four elements of the visions. From these policies are developed an estuary management system, interlinked with estuary programs, plans and designations. In the estuary management system, a policy committee, key agency group and program committee work together with the lead agencies through three special processes: a participation process, a coordinated referrals and assessment process, and a Fraser Estuary Information System (FEIS). The estuary programs, plans and designations are divided into three main divisions: activity programs covering port terminal, navigation traffic, habitat management, waste management, recreation and parks, etc.; area designation; and management area plans for each specific designated area of the estuary.

The following summaries of user group and government agency concerns regarding management of the Fraser River Estuary, presented in "a Living River by the Door"¹³, illustrate the diverse range of private, commercial, and public interests which an integrated management plan must attempt to reconcile in a manner which is consistent with maximum benefit to all. These summaries are included as they represent a multi-interest, multi-party, multi-jurisdiction situation, which provides a reasonable model of what a coastal planning team might expect to encounter:

Fraser River Estuary user group concerns -

- i) "The forest industry wants to assure that the estuary is managed as part of the coast-wide log movement system. Log storage in the estuary is essential due to the need for inventories for mills, high cost of land storage, and the lack of alternate water storage sites.

- ii) The marine transportation industry wants to ensure that navigation channels are capable of handling anticipated demands for goods movement. Areas for industrial development to be identified so industry can plan and maintain unrestricted water access.
- iii) The fisheries industry wants the commercial fish base to be maintained. Improved enforcement of pollution control legislation, preservation of habitat in the estuary, and salmonid enhancement are required.
- iv) Unions want employment to be an objective of estuary management.
- v) Natives are concerned about controls on economic development within Indian Reserves. The onus for protection of the environment should not fall on natives who were the last to develop their lands.
- vi) Agricultural interests want the economic value of farming to be recognized and future values protected. Urban uses have alienated and inflated the price of farmland.

Additional farmland may be needed in the future to replace soil types that are being taken out of production.

Fraser River Estuary - government agency concerns -

- i) Agencies responsible for managing port and port-related industrial development are concerned about encouraging, accommodating and servicing deep-sea and shallow-draft shipping. ...there is a strong feeling that the economic benefits of port development have not been adequately considered in past decision-making. This has led to excessive delays in project approvals and inflexibility by resource management agencies.
- ii) Biological resource management agencies want to preserve remaining habitat in the estuary and ensure its continuing productivity. Historic habitat loss, cumulative effects of

foreshore fill from hundreds of small projects, and impacts of major projects on river flow and patterns of sedimentation and erosion are all viewed as threats. Buildup of persistent pollutants such as heavy metals and organic contaminants can place long-term productivity at risk.

- iii) Water quality management agencies seek to maintain good water quality by eliminating toxic pollutants, improving treatment of effluents, and improving monitoring and enforcement. ...discharges should be regularly monitored and illegal discharges should be halted through vigorous enforcement of existing regulations. Continued monitoring of effluents in receiving water is needed to provide a better base for future decisions.
- iv) Local governments want greater involvement in guiding decisions by federal and provincial agencies which affect upland use. It is felt that the views of senior governments tend to dominate in estuary decision-making, that impacts on local communities are inadequately assessed, and that local needs are not considered.

Decisions affecting land use, resource management and major developments should consider official community and regional plans and also be assessed to reduce local impacts, such as noise, aesthetic impacts, and demands on transportation and services. Municipal councils and regional district boards and Indian bands should be consulted and their staff should be involved in estuary planning, decision-making and implementation.

Improved public recreation access points are needed, but municipalities lack funds to acquire them. Municipalities support high water quality but feel that they lack the authority to maintain water quality in tributaries and drainage ditches. In addition there is concern over the costs to local governments of programs for secondary treatment and source control. Lack of acceptable sites for municipal landfills is also a growing problem.

Local governments expect more direct accountability by senior governments for their actions which affect local government interests."

Obviously, reconciliation of such diverse interests would involve a sophisticated system of negotiation and bargaining in the development of goals, objectives, management strategies, and programs for implementation and monitoring. The next section of this paper addresses the difficult question of resolution of disputes which occur in a public interest context.

It should be noted that the Fraser River Estuary Management Plan officially came into being October 10, 1985, through the signing of a five-year agreement which included five major representatives: Environment Canada, the B.C. Ministry of Environment, the Federal Department of Fisheries and Oceans, the Fraser River Harbour Commission, and the North Fraser Harbour Commission. The Management Plan incorporates a central office in New Westminster to facilitate the operation of a coordinated project review process. The key components to the process are described in the Estuary Management Program's Annual Newsletter (issue No. 1, March, 1986):

- i) Lead agencies (responsible for issuing leases or permits);
- ii) Common application forms;
- iii) A central project registry, at the Secretariat Office in New Westminster; and,
- iv) An Environmental Review Committee. This Committee, composed of Environment Canada, Federal Fisheries and Oceans, and B.C. Ministry of Environment, reviews comments of environmental agencies on project proposals, advises lead agencies of environmental concerns relating to these proposals, and determines if further environmental review is required at more sophisticated levels.

The Secretariat office has continued to produce annual newsletters which indicate that steady progress is being made and, although it is beyond the scope of this paper to analyse the success of the program, it would appear that

full implementation of the program will, like the process which led to its creation, take considerable time and effort. What appears to have been the main obstacle to the creation of FREMP will likely continue to be the main obstacle to continuing success: namely, the fragmented jurisdiction and enforcement authority of the many agencies involved, which the management program itself was intended to overcome. However, progress to date would indicate that all parties agree that the effort is worthwhile.

C. Integrated Resource Management and Planning: Summary

The material chosen for inclusion in this section is intended to illustrate, in a limited fashion, the scope of administrative knowledge and experience in B.C. pertaining to resource planning and management, and as well to provide a brief "primer" in the basic principles of this discipline. It is the opinion of this office that adequate administrative tools can be created to manage effectively and fairly the diverse resources within the coastal zone of the province. Fairness for individuals, companies, and communities demands that resources be managed and allocated in a manner which provides for a broad range of meaningful participation within a framework of long-range planning.

As a final note on the subject, it should be remembered that good planning requires good data; the Coastal Management systems of the American states reviewed in this report all allow for the vital functions of inventory gathering and mapping. This necessity has not gone unnoticed in British Columbia; the Ministry of Crown Lands is at present coordinating the development of a prototype computerized Geographic Information System (G.I.S.) which will provide an integrated, multi-use database. The prototype will be tested in the spring of 1989 for applications with the Ministry of Environment.

Apart from data collected for the CRIS study, there has as yet been little work done for coastal inventory purposes; however, the G.I.S. shows promise as an effective tool for the handling and interpretation of coastal data as it is acquired; its ultimate role as a component of integrated resource management would be vital.

P A R T VI

THE RESOLUTION OF PUBLIC INTEREST DISPUTES

- . PUBLIC INTEREST DISPUTE RESOLUTION IN COASTAL
RESOURCE GOVERNANCE: THE STATE OF THE ART IN B.C.
- . WHEN SYSTEMS GET STUCK: RESOLVING PUBLIC
INTEREST DISPUTES THROUGH A CONSENSUAL APPROACH.

Public Interest Dispute Resolution in Coastal Resource Governance: The State of the Art in British Columbia

In 1986 the Westwater Research Centre at the University of British Columbia published an insightful text entitled, "Bargaining in the Governance of Pacific Coastal Resources: Research and Reform". This book outlines the "governance challenge" and the state of bargaining among the various interests in the present coastal resource governance system. Bargaining, as the term is used by Westwater, encompasses negotiation and agreements within a spectrum of legal structure ranging from informal understandings to legislation.

The bargaining, of course, occurs among and between the various levels of government and private groups and individuals be they single land owners or commercial or community interests. It is helpful to review Westwater's analysis of four types of conflicts, arising within the context of resource management or allocation, which can be identified:

1. Cognitive conflict is rooted in different understandings of the situation. Example: while both fisheries biologists from the forest industry and biologists from fisheries agencies might be equally concerned about damage to fish in the case of log booming in the Cowichan Estuary, the disagreement might well be over whether the damage is in fact occurring.
2. Value conflict stems from different judgment about the ends to be accomplished by the action contemplated. Example: differences in two parties' judgments about the desirability of trade offs between environmental quality and economic growth.
3. Interest conflict: this occurs when there is disagreement about the distribution of the costs and benefits. It results from differences in judgments about who should pay and who should benefit.
4. Behavioural conflict is rooted in the personalities and circumstances of the interested parties.

The Westwater text goes on to outline certain basic principles of governance which should inform the bargaining process. The fact that these principles are expressed in almost constitutional terms reinforces the premise that they represent fundamental assumptions without which the bargaining process is likely to fail. The principles are outlined as follows:

1. All individuals have certain inalienable rights that cannot be violated by the courts, ordinary legislative actions or administrative organizations.
2. Individuals and groups should be treated fairly by society. From the principles of fairness stem expectations of how those legitimately involved in the bargaining processes of governance should be treated.
3. Subject to basic rights and fairness, the preferences and priorities of all individuals affected have equal merit in governmental decisions. In the governance of Pacific coastal resources, representatives are elected in this manner to three decision-making arenas: parliament, the Legislature and municipal councils. Regional districts and the Islands Trust are a fourth set of arenas but the representatives are not necessarily elected directly. The valuation of a governance system must assess how well procedures for leadership and accountability operate throughout the bargaining processes.

The principles of governance lead to the basic principles of bargaining. These principles were first presented by authors Fisher and Ury of the Harvard Negotiation Project in their book, "Getting to Yes":

1. Separate the people from the problem. While you should be soft on the participants, you should be hard on the problem that is to be resolved. The goal should be a wise outcome reached efficiently and amicably, and defined as "one which meets the legitimate interests of each side to the extent possible, resolves conflicting interests fairly, is durable, and takes community interests into account";
2. Focus on interests, not positions.

3. Invent options for mutual gain.
4. Insist on explicit criteria.

These principles in and of themselves do not provide a totally adequate foundation for the resolution of public interest disputes, but nonetheless represent "the state of the art" as at 1985. More recent publications, most notably a text entitled, "Breaking the Impasse", a result of the MIT - Harvard Public Disputes Program, have built upon these principles for the resolution of multi-party, multi-interest disputes in a public context.

Westwater's text emphasizes three questions in applying these governance and bargaining principles to the evaluation of the governance of Pacific coastal resources:

1. How well informed are the participants in the bargaining processes?
2. How adequate are the opportunities for informed participation or representation of affected interests in the bargaining processes?
3. How productive are the bargaining processes?

These are questions which cut to the heart of the process, and apply with equal force regardless of the techniques of bargaining being employed. The development of the argument continues, by drawing upon research by Mason and Mitroff,¹⁴ to declare that "the best understanding of large inter-dependent, complex and uncertain systems can be achieved by structuring a debate among those possessing whatever knowledge is available." Mason and Mitroff, as quoted in Westwater's text, suggest that "real world problem solving methods must meet four criteria":

1. They must be "participative" because they must actively involve the individuals with relevant knowledge and whose interests are affected.
2. They must be "adversarial" in the sense that the best judgments result from constructively challenged assumptions and arguments.
3. They must be "integrative" because, while participative and adversarial processes can facilitate analysis, it is necessary to go on to synthesize coherent responses to complex problems.

4. They must be "mind supporting", because they must serve the individual's ongoing need for insight into the nature of the complexities and ways for coping with it that are credible to that person. (p.94).

These four criteria, as employed by Westwater in combination with the techniques of Fisher and Ury, represent an attempt to achieve broader application for the resolution of public interest disputes. This office would interpret the ultimate goal of this exercise as being to produce a set of principles for consensual resolution. The application of "adversarial" techniques in order to challenge assumptions and arguments constructively requires commitment, tolerance, and patience from the negotiating parties, and the results achieved will be directly proportional to the skills of the participants. It therefore comes as no surprise that it is argued later in the text that skills in communicating, challenging constructively, and bargaining successfully, must be increased through effective training and education in order to increase the productivity of the bargaining system. While the Westwater's text suggestions are both innovative and constructive, it should be noted that they are intended to be applied primarily within a context where explicit third party mechanisms (e.g. legislated appeal or mediation systems) are not available. The assistance of a trusted, neutral facilitator or mediator, knowledgeable and skilled in techniques of consensual dispute resolution, will be perhaps more vital to the process than trained participants. For complex, multi-party resource management or allocation disputes (in which some parties will inevitably have inordinate power and influence) it should not be expected or required that each party with a legitimate interest to bring to the bargaining table will possess the necessary skills.

It is interesting to note that the Westwater Research Centre classifies mariculture, that is, marine aquaculture as a classic "wicked" problem because the inter-dependence, complexity, and uncertainty of the issues to be resolved create questions which are not amenable to resolution by traditional techniques of analysis.

"Bargaining in the governance of Pacific Coastal Resources: Research and Reform" concludes with observations of weaknesses which continue to exist and hamper optimum effectiveness [and, this office would suggest, the fairness] of current institutional structures. It is the opinion of this office that the criticisms apply with equal force at the present time:

- The new institutional arrangements, with the important exception of those for conducting public enquiries and impact assessment, generally do not constrain bargaining but they also do not explicitly recognize it;
- The formal structures for conducting public enquiries do not facilitate bargaining, but rather induce negative adversarial relations and encourage positional bargaining;
- Structures for facilitating bargaining and planning have generally received little development so far.
- Lack of leadership has greatly frustrated the bargaining processes.
- Without leadership and associated strategic planning to inform the bargaining, meaningful accountability has been impossible.

The Westwater text notes the fundamental importance of planning in order to provide a broad policy context within which the impact of specific projects can be assessed. However, it also notes that the planning which has occurred to date has had a primarily areal focus on the coast, being undertaken at the regional and sub-regional level, rather than coast wide.

WHEN SYSTEMS GET STUCK: RESOLVING PUBLIC INTEREST DISPUTES THROUGH A CONSENSUAL APPROACH

This section briefly examines the nature of public interest disputes involving citizens and their government and considers alternatives to litigation for resolving them. In doing so, it recognizes the massive impact of the public sector on modern society. While administrative action is the most intrusive and dominant influence on all of our personal, commercial and social interests, traditional legal remedies and processes are frequently impotent to hold the public sector accountable for the fair and effective reconciliation of apparently adverse interests.

The types of disputes previously referred to in this paper involve competing demands for public resource use and allocation rights. These should be distinguished from disputes involving pure constitutional issues, contract terms or tort claims. The courts are very effective in interpreting the law, determining fault and assessing damages. They may also play a vital role in defining rights in situations where legislation is lacking or provides little guidance, and where the common law does not provide clear direction. However, the adversarial process is not well suited for achieving an enduring solution to various competing but legitimate interests within and between governments and private individuals and corporations.

While litigation may not be the most appropriate way to resolve public interest disputes, the public administration itself is often incapable of responding sensitively to competing interests. Administrative policy and practice must be adapted to act more fairly and effectively in the first instance so that the urge or need to litigate does not arise.

All of the public and private interests mentioned in this paper are legitimate, compelling and often competing. They are also interdependent and the failure to reconcile them will be to the detriment of all. However, neither the courts nor the current administrative structure may well be suited to ensure a balanced and enduring resolution. Clearly, an integrated and consensual process is required which will identify the common interests among the various parties and achieve a result to which all can voluntarily subscribe.

A. Litigation Concerns

Litigation will almost always be the least appropriate way to resolve public interest disputes for the following reasons:

1. The interests and issues are usually too numerous to benefit from an adversarial process and a simple win-loss decision. Characteristic of public interest disputes is the interdependence of the various competing interests. Effective resolution requires a voluntary crafting of mutually acceptable terms and trade offs, and the adversarial court process is ill suited to this need.
2. The expenses and delays involved in complex litigation may favour parties with the greatest resources, but not necessarily with the highest and most legitimate degree of interest.
3. Private interests will never be the equal adversary in litigation given government's effectively limitless resources, its political and institutional stake in its own policies, and its control over information.
4. Many administrative and executive decisions and actions of government are non-reviewable on their merits and therefore there is simply no remedy at law to their potential unfairness or unreasonableness.
5. Where litigation succeeds in changing or setting aside government action, the result may simply be avoided by a subsequent change in the legislation or in the process by which an offending decision or action was taken.
6. Government has a harmonizing role in society as well as a regulating one, and it is often unseemly and inappropriate for it to be in court with its citizens. Because of its special responsibilities, government owes a duty of fairness to individuals in society which can go well beyond bare statutory or other legal mandate and responsibility. The courts can not deal with such fairness issues. Indeed, as soon as litigation commences or is even contemplated, positions harden along legalistic lines and broader fairness issues can get lost.

7. Court decisions are imposed against the will of the losing parties. As such, in public interest disputes, although they may create legal rights they are unlikely to attract the cooperation necessary for continuing enjoyment of those rights. Adverse publicity campaigns, continuing legal challenges, civil disobedience, political agitation and simply a lack of necessary cooperation can eliminate stability from a court awarded victory.
8. Courts are not well suited to resolving the dynamic issues in situations that often arise in public interest disputes. A resolution must be sufficiently flexible to allow for changing circumstances and the inability or unwillingness of courts to play a monitoring role reduces their effectiveness in resolving such disputes.
9. Public interest disputes are often miscast as one dimensional battles between economic and social interest, with recourse to litigation seen as the only way to divide the spoils or declare the victor. Yet the courts are not well suited to providing a solution which is flexible, self-regulating, enduring and mutually productive. Social harmony, political consensus and economic competitiveness are essential objectives in public interest disputes. All are poorly served by an adversarial process which imposes settlements, drains resources and distinguishes winners and losers.

B. Consensual Resolution

The consensual resolution of public interest disputes requires a recognition by all major private and public interests that the best chance of achieving their individual objectives will occur through the enhancement rather than at the expense of apparently competing interests.

This is a building process rather than a destructive one. It exhibits the following major characteristics:

1. While it requires creativity, patience and goodwill, it does not require self sacrifice. In fact, self interest is its sustaining force.

2. Because the various interests will value aspects of the public issue differently, resolution packages can be crafted which satisfy each party's major concerns while trading off less vital ones.
3. The interdependence of interests empowers even relatively minor stakeholders to be valued partners in the resolution, rather than bothersome but beatable opponents.
4. It is a negotiated process, not an adversarial one, which will likely require the assistance of a trusted, neutral facilitator or mediator to ensure free communication, full disclosure and balanced participation.
5. It is essential that all significant interests voluntarily involve themselves in the process, through the participation of a legitimate and authorized representative. Each party must believe that its particular interest will be better served by a negotiated settlement than by an imposed one. If any one party believes it can win the dispute outright, judicially or politically, then the process will not work.
6. The process requires each party to define its objective in positive terms, rather than negatively saying what it absolutely doesn't want some other party to do. By thinking in terms of what it wants to achieve, each group becomes better disposed to accommodate apparently competing interests by concentrating on creative alternatives for reconciling them.
7. Government must show leadership in promoting consensual resolution rather than confrontation. It may be required to fund the mediation, research, resource and representation costs of some or all of the parties to ensure full and effective participation in the process.
8. Because solutions are voluntarily entered into, they will be self-regulating and enduring. Because they have been designed through a process based on openness and respect, the positive relationship will allow flexible adjustment of terms to meet changing circumstances in the future.

9. Business interests will gain from stability and certainty in the exercise of commercial rights, and from an enhanced reputation as good corporate citizens.
10. Special interest groups will play an influential role in designing solutions to difficult public conflicts. They will be recognized as legitimate participants introducing important concerns to the process rather than strident and absolute positions.
11. Where scientific, technical, legal or other experts are required to advise the process, they should not be engaged to align with particular interests, but rather to develop a common set of acceptable assumptions, standards or conclusions on which joint decision-making can be based.
12. The legal profession will undoubtedly play a major role in consensual negotiation as mediators, counsel or expert advisors. More fundamentally, lawyers must be able to redefine the notion of success for their clients. Public interest disputes are often won, not through winner-take-all but often illusory court victories, or through cost and risk cutting compromises, but rather through voluntary, enduring, mutual-gain solution building.
13. Our overburdened court system would clearly enjoy the absence of protracted, multi-party public interest law suits to which its remedial tools are not well suited. It may be that judges can assist the diversion of such disputes by appointing or recommending pre-trial or mid-trial mediators or masters to work with the parties towards consensual resolutions under the alternative threat of a costly and inadequate court imposed settlement which may fail to meet any party's major interest.
14. Consensual resolution requires courage from the participants. Single interest confrontation is straight-forward in that each representative feeds off the support of his or her interest group. However, it takes boldness and skill to bring one's own group over to supporting another group's objectives in its own enlightened self-interest.

15. Fundamentally, consensual resolution is a reasoning process rather than a coercive one; as such, it is immensely more powerful. A reasoning process stimulates a voluntary change in the way of thinking which endures to the benefit of all parties in the future. By building understanding and respect among the parties, it generates productive energy. In contrast, a coercive process drains energy from all parties and produces a weak outcome by leaving embittered and resistant losers.

Application of Consensual Dispute Resolution: Aquaculture

While there is an obvious multiplicity of interests in the administration and management of the British Columbia coastline, many of which appear to be diametrically opposed, there is nonetheless no need for these interests to be engaged in destructive opposition with one another. Environmental quality is as important to entrepreneurs investing in a vulnerable stock as to conservationists concerned with a vulnerable wilderness; broad and meaningful participation in long range planning at once satisfies all the community and individual interests in protecting property, the government concern to make decisions based on all relevant information, and the business need for a certain and stable investment climate. Integrated management of abundant but finite coastal resources can put different areas to the appropriate and optimum use of each distinct interest; and revitalized coastal economies will help to finance the preservation and enhancement of other interests.

The administrative practices and consensual initiatives discussed above can be applied towards a resolution of the aquaculture controversy. Similarly, the approach is appropriate to resolving a wide range of public interest disputes which otherwise divide society and frustrate our judicial system. Rapid transit systems, pesticide use on public lands, hazardous waste disposal, natural resource allocation and land use decisions, aboriginal rights issues and countless others are both amenable to consensual resolution and inappropriate for judicial intervention.

The various elements of this approach are not novel. It is clearly recognized, for example, that voluntary collective bargaining will produce the most enduring and mutually beneficial results to both labour and management; and mediated settlements in family disputes work to

everyone's advantage. However, as our communities become more pluralistic, as our natural resources become less abundant, as society becomes more interdependent and as international economic competition becomes more fierce it is clear that public interest litigation is not the answer. We simply can not afford the debilitating waste of energy and good will that such disputes cause or the cost and burden of government regulation and judicial intervention required to control them.

Instead, individual self-interest must be creatively and realistically identified as being inextricably linked to that of other interests in society. The consensual resolution of public interest disputes requires maturity and clear thinking, but it has the potential to promote social harmony and economic growth in an otherwise complex and threatening environment.

A most notable and successful example of consensual dispute resolution within the context of integrated resource management is the Timber, Fish, Wildlife Agreement (TFW) negotiated in Washington State. It represented a radical departure from the traditional method of reconciliation of interests, which was to fight fierce battles in State Legislatures, the State courts, Ministry bureaucracies, Federal courts, in Congress, or the White House. A description of the background, negotiation process and applicability to the Canadian context of the TFW Agreement is provided in Appendix 13.

P A R T VII

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

This report concludes with three major recommendations, with sub-recommendations for each:

RECOMMENDATION 1:

The government should reconsider the statutory authority for the administration of aquaculture with a view to the enactment of a separate Aquaculture Act, or other statutory scheme which gives clear, coordinated and express authority in this area.

It has been stated that the creation of such an Act would require administration by a "neutral agency", and would create anomalies and inconsistencies among programs administered by other agencies. This is not an insurmountable burden and in fact is encountered and overcome when most new legislation is introduced. While it would be possible to amend the Land Act to provide a statement of objective and binding criteria, this may not adequately meet the needs of the industry or coastal communities, given the inter-disciplinary, inter-ministerial nature of the subject. A separate Aquaculture Act would not prevent government from playing an active role in promoting aquaculture in the context of regional and economic development. It would simply mean that the decision-makers charged with performing regulatory functions should be required to give due consideration to all affected parties in the administration of the Act. Conflict is likely to be substantially reduced if the aquaculture industry can be clearly seen to be the subject of impartial regulation.

An alternative route, although somewhat fragmented, is for amendments to be made to existing legislation such as the Land Act, the Fisheries Act, and the Waste Management Act, or regulations thereto, to deal specifically with aquaculture issues. Any such regulatory amendments should be consolidated under a single Order in Council, for clarity and ease of reference.

It is a matter of legislative policy, on which this office expresses no opinion, as to whether an Aquaculture Act should incorporate land allocation (leasing or licencing) provisions. The approval of a management plan to carry on the practice of aquaculture, and the granting of tenure to occupy a parcel of aquatic land exclusively, are separate and distinct processes. However, whatever mechanism is employed, the legal requirements should have a published statutory foundation, whether through an Aquaculture Act, amendments to the Land Act, or other legislation.

(a) An Aquaculture Act, or alternatively amendments to existing statutes and regulations, should emphasize the following elements in its design, in order to maximize certainty and administrative fairness:

- i) facility siting consistent with long-term development plans produced through application of principles of integrated resource management with meaningful participation for all affected parties;
- ii) siting and operational requirements consistent with high standards of environmental integrity with provision for effective environmental monitoring and reporting. Aquaculture facilities should not only have a duty to participate in maintaining environmental integrity, but should also be able to rely on provisions aimed at protecting the quality of their own water supply, whether fresh or marine;
- iii) efficient appeal mechanisms which would provide access by all significantly affected parties to an independent, expert tribunal, prior to a final grant of tenure;
- iv) explicit recognition of the authority of local or regional governments to establish areas in which specific aquacultural activities may be limited;
- v) the property rights of aquaculturists to the cultured species being raised within their facilities, to provide legal assurance of ownership, including the ownership of escaped fish within a prescribed radius of the facility;
- vi) provision for the office of an Aquaculture inspector, with broad powers of investigation, to enforce the legislative requirements;

- (b) Ministry policies (the manner in which a Ministry interprets and implements its mandate as determined by statute or ministerial directive) should be published in plain language and made readily available.
- (c) The inter-ministerial (and inter-group) referral system, by which information on a proposed aquaculture installation is solicited from interested and affected parties, should provide for exchange of referral comments and information among the referees, and written reasons should be provided by the appropriate ministry (e.g., Crown Lands and/or Agriculture and Fisheries) to explain and justify decisions made or action taken.

In addition, there should be, in situations where referral comments indicate significant conflict, a further period for rebuttal comments to be circulated among the referral entities.

- (d) A neutral Impact Assessment mechanism should be integrated into the overall aquaculture facility licencing and permitting structure. It should be open to public involvement, with written reasons provided for decisions made. However, it should not require such expense or delay that meritorious projects would suffer unduly, which in itself would constitute administrative unfairness.
- (e) Visual impact and site-specific facility design criteria should be developed to maximize "blending" of aquaculture facilities with their surroundings, particularly in areas where such development has not been previously introduced.
- (f) Internal and external appeal processes relating to facility siting, granting of tenure (lease or licence), and facility operations (e.g., impact beyond waste management limits) should be put into place, and be available to all significantly affected parties. The external appeal body should be independent and expert, with at least one member knowledgeable in principles of

administrative law. If the Land Act is to continue to be employed as the governing statute for aquatic land allocation, the appeal provision (s. 59) should be replaced with internal and external appeal systems which reflect the basic tenets of administrative fairness as set out herein. Opportunities for consensual dispute resolution should be available as alternatives to these appeal processes: see Recommendation 3.

- (g) Advertisements giving notice of application for disposition of Crown land should clearly indicate, in non-technical terms, with words and diagrams, the location and size of the proposed facility. Signs posted on land should face the water and any nearby travelled roads; location on the proposed development area should be designated; for maximum visibility they should be readable from a reasonable distance, e.g. 30 metres. Because a parcel of "aquatic land" is of necessity travelled by marine transportation, notice to the marine community or nautical commuters should be provided by means of a clearly visible sign attached to a coloured buoy anchored at or near the centre of the proposed tenure.

RECOMMENDATION 2:

A framework for integrated management of resources and activities in the coastal zone should be created, with appropriate enabling legislation, as a mechanism to enhance administrative fairness in all aspects of coastal planning, resource allocation, and management by Provincial Ministries.

Note: A new "coastal zone management" Ministry need not be created. What is suggested is an integration, through specifically stated priorities, of existing management capabilities. It is inevitable, however, that an office - perhaps in the nature of a Secretariat - would be required to provide coordination, review, and reporting functions.

- (a) Coastal management should emphasize and facilitate community planning and control. Community plans, produced in conformity with

provincial goals and objectives, appear to be a useful vehicle for maximizing administrative fairness and minimizing conflict if a litigation model is to be avoided.

- (b) Public participation should be given explicit priority and accommodation at all stages of coastal planning processes. This is a corollary of (a) above.
- (c) An inventory of coastal resources, produced in cooperation with local municipalities or regional districts, should be created as the foundation for coastal planning. Recommendation 1(D) of the Coastal Zone Resource Sub-Committee (Appendix 11) would appear to be a good model for resource inventory and related information-gathering functions.
- (d) A comprehensive set of priorities (as was articulated in the proposal for a Fraser River Estuary Management Plan) should be produced, published, and refined through broad public participation. From these can be produced specific goals and objectives, which can then be translated into specific management plans to provide a framework within which local government can establish its own priorities. Publication of priorities - providing citizens with a long-range view of what is contemplated or proposed - is essential to maximizing administrative fairness within the context of resource allocation and management.
- (e) The concept of "highest and best use", as employed by the Ministry of Crown Lands to determine appropriate use of specific parcels of land, (or aquatic land) should be abandoned and replaced with sound integrated resource management criteria. "Highest and best use" most often is equated with maximum economic yield, and may therefore conflict with values advanced by other Ministries, conservationists, environmentalists, tourism and recreational interests, or Native Indian bands.

RECOMMENDATION 3:

Consensual dispute resolution (CDR) techniques, as outlined in this Report (pp. 89 - 96) should be recognized, promoted, and applied as official policy by all relevant Ministries, and should, as appropriate, be recognized and implemented through amendments to existing legislation. CDR techniques should be available as an option for the resolution of aquaculture-related disputes which may occur at any stage of the priority development or project development process.

There remain a number of potentially contentious matters noted below which are beyond the jurisdiction of the Office of the Ombudsman, and upon which no opinion is expressed. However, these concerns may be amenable to a process of consensual dispute resolution:

- rights and desires of Native groups to control, be involved in, or limit aquaculture development;
- impact on the commercial fishing and fish processing industries (both economically through competition and by potential effects on wild salmon stocks) of salmon net-pen operations;
- use of antibiotics in fish husbandry and the possibility of introduction of residues into the human food chain;
- use of anti-foulant chemicals on fish farm nets and their impact on the surrounding environment and aquatic species, and potential questions concerning chemical residues entering the human food chain;
- impact of net-pen facilities in general upon the environment, and the degree to which the seabed, aquatic organisms, and adjoining waterfront areas are affected;
- labelling of farmed fish as to their origin, at point of sale.

The above issues often involve diametrically opposed claims which purport to be based on valid scientific data. With expert pitted against expert, and no independent, authoritative agencies involved to mediate the dispute, it is no surprise that an impasse on any of these matters may be quickly reached.

There are also social and economic policy matters beyond the jurisdiction of this office which form the context for the advancement of competing claims. Collectively, these questions make a compelling case for the creation of consensual dispute resolution mechanisms which will allow the facts to be determined neutrally and creative options for the mutual enhancement of interests to be explored.

FOOTNOTES

1. Marden, The Continental Shelf: Man's New Frontier, 153 National Geographic 495 (Ap. 1978), quoted in Bowden, Gerald, Coastal Aquaculture Law and Policy: A Case Study of California, Boulder, Colorado: Westview Press, 1981, p. 1.
2. R.S.B.C. 1979, c. 214.
3. R.S.B.C. 1979, c. 306.
4. R.S.C. 1970, Chapter F-14.
5. R.S.C. 1970, Chapter N-19.
6. Re Attorney General of British Columbia and Attorney General of Canada (Georgia Strait Reference) (1984) 8 D.L.R. (4th Series) 161 (Supreme Court of Canada).
7. R.S.B.C. 1979, c. 137.
8. Tynan, B. Aquaculture - The Constitutional Framework, Private Paper, p. 1.1.14.
9. R.S.B.C. 1979, c. 136.
10. Finkle, P.Z.R., and Lucas, A.R., ed., Fairness in Environmental and Social Impact Assessment Processes, Canadian Institute of Resources Law, Faculty of Law, University of Calgary, 1983, p. 14.
11. Source: Development of Aquaculture in Sweden, by Hans Ackefors, published by the Swedish Council for Planning and Coordination of Research, in collaboration with the National Marine Resources Commission, 1983
12. Sources: Fiskeridepartementet Informerer. Fish Farming - Act of 14th June 1985, No. 68, relating to the breeding of fish, shell fish, etc. (With comments on the individual provisions in the proposal for the Act). -

Fiskeridepartementet Informerer. Summary of Report No. 65 (1986-87) to the Storting (Norwegian National Assembly) on Aquaculture.

Bjorbaek, Cari and Hempel, Erik: **The Status of Norwegian Salmon Farming.** Royal Norwegian Ministry of Fisheries, Oslo.

13. Government of Canada and Province of British Columbia
A Living River by the Door - A proposed Management Program for the Fraser River Estuary. March, 1982, pp.16-18.
14. Mason, R.O., and I.I. Mitroff. 1981. **Challenging Strategic Planning Assumptions: Theory, Cases and Techniques.** New York: John Wiley and Sons.

APPENDICES

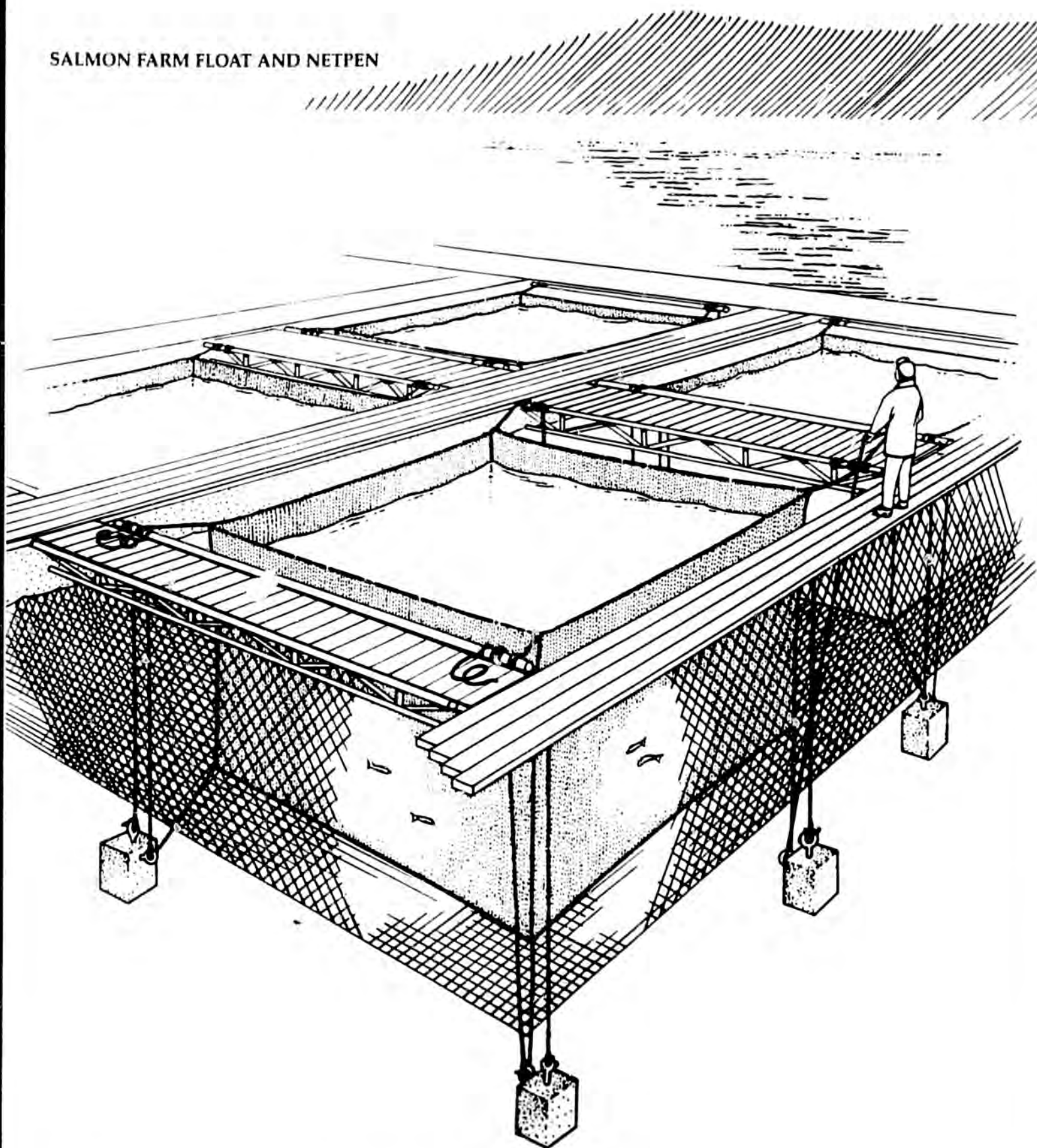
1. Diagram: Net-pen facility (courtesy Ministry of Agriculture and Fisheries)
2. Aquaculture Licencing and Approval Flowchart
3. Distribution of legislative jurisdiction over foreshore and sub-aquatic lands in British Columbia (From Tynan, B.)
4. Swedish application and referral process (From Ackefors, H., "Development of Aquaculture in Sweden")
5. Excerpt from Washington State "Aquaculture Siting Study"
6. Washington State Shoreline Management Act of 1971 (excerpts); Coastal Zone Management Act of 1972 (U.S./Federal excerpts)
7. Etolin Island area Mariculture Pilot Project final report, re coastal use conflict and siting guidelines. (excerpts)

Alaska Coastal Zone Management Program (excerpts from statute); Alaska Coastal Zone Managment Program - 1986 Annual Report (excerpts)
8. Oregon Coastal Management Program Summary
9. Fraser River Estuary Mangement Program - flowchart (from "A Living River By the Door")
10. Aquaculture Industry Overview: Statistics
11. Excerpt from Summary of Recommendations of Coastal Zone Resource Sub-Committee (May 1977)
12. Possible impacts of a salmon farm upon the marine environment (courtesy Ministry of Environment and Parks)
13. Commentary on Washington State Timber, Fish and Wildlife Agreement.

APPENDICES

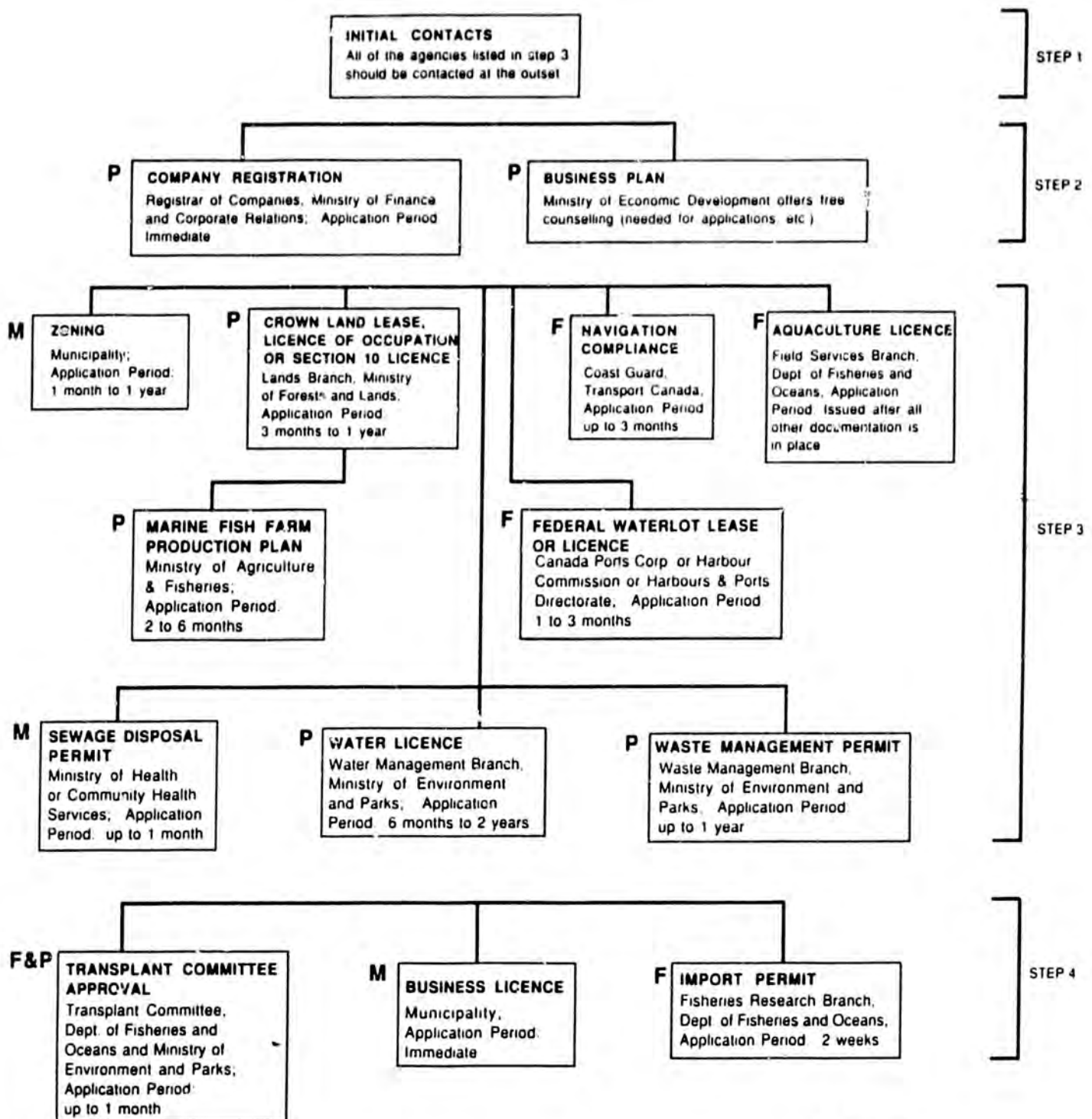
1. Diagram: Net-pen facility (courtesy) Ministry of Agriculture and Fisheries)

SALMON FARM FLOAT AND NETPEN



2. Aquaculture Licencing and Approval Flowchart

FIGURE 4. PERMIT AND LICENCE STRUCTURE FOR MARINE FINFISH CULTURE.

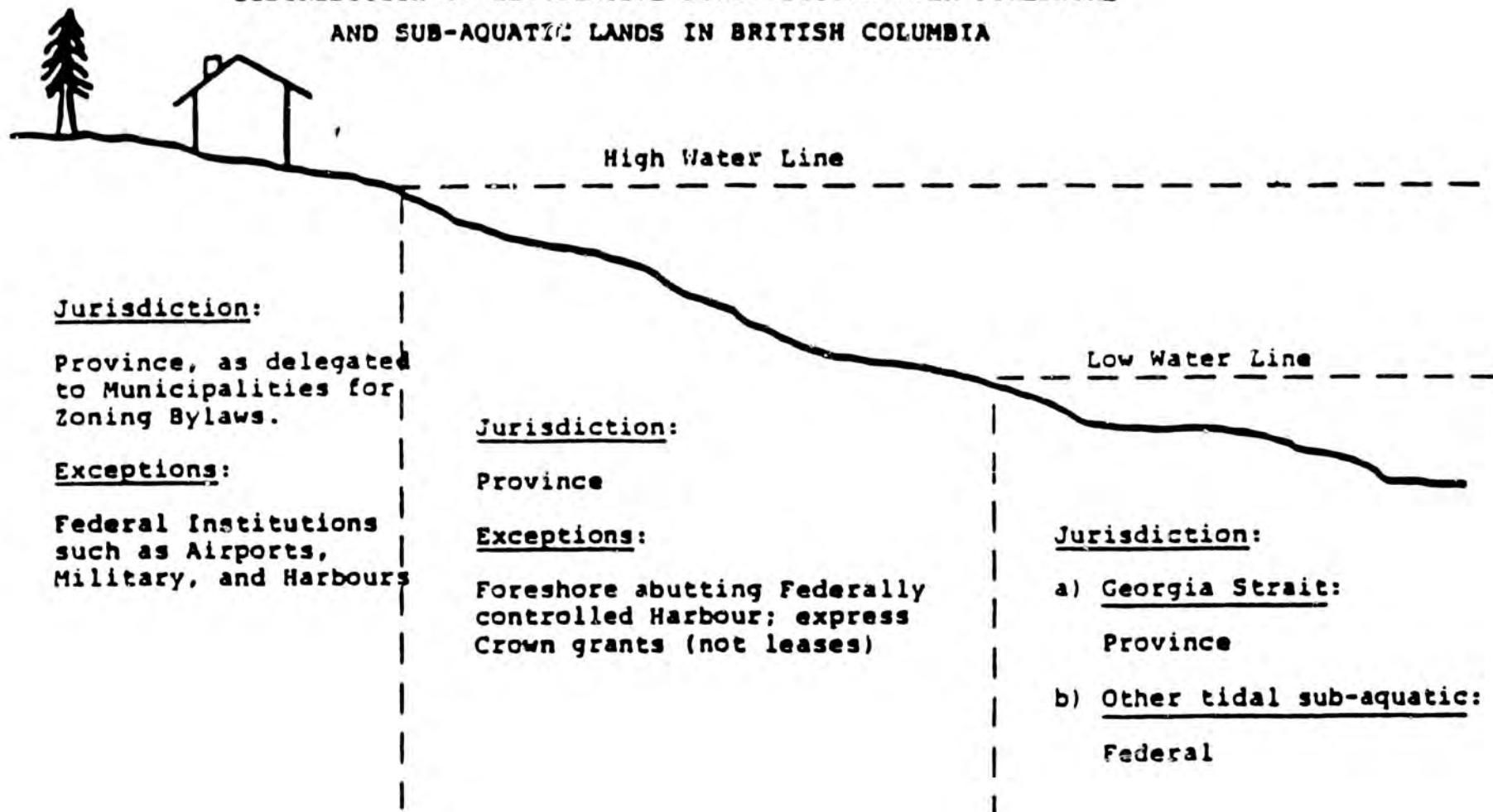


- 1) Permits or licences listed are not required in all instances
Contact the agencies indicated to determine the individual requirements for specific farms
- 2) Marine Fish Farm Production Plan was previously called Salmon Farm Management Plan

F = Federal
P = Provincial
M = Municipal

3. Distribution of legislative jurisdiction over foreshore
and sub-aquatic lands in British Columbia
(From Tynan, B.)

DISTRIBUTION OF LEGISLATIVE JURISDICTION OVER FORESHORE
AND SUB-AQUATIC LANDS IN BRITISH COLUMBIA



4. Swedish application and referral process (From Ackefors, H., "Development of Aquaculture in Sweden")

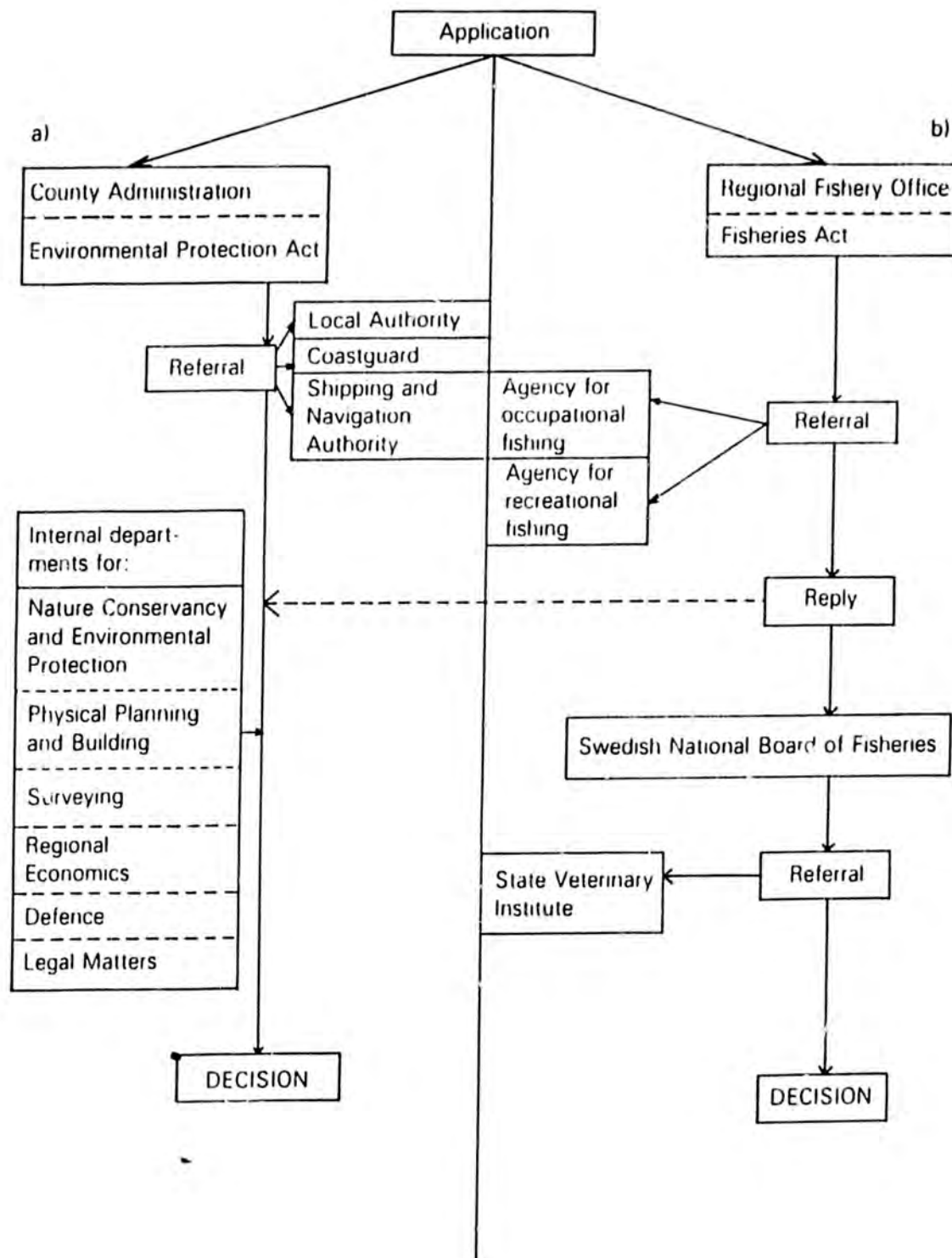
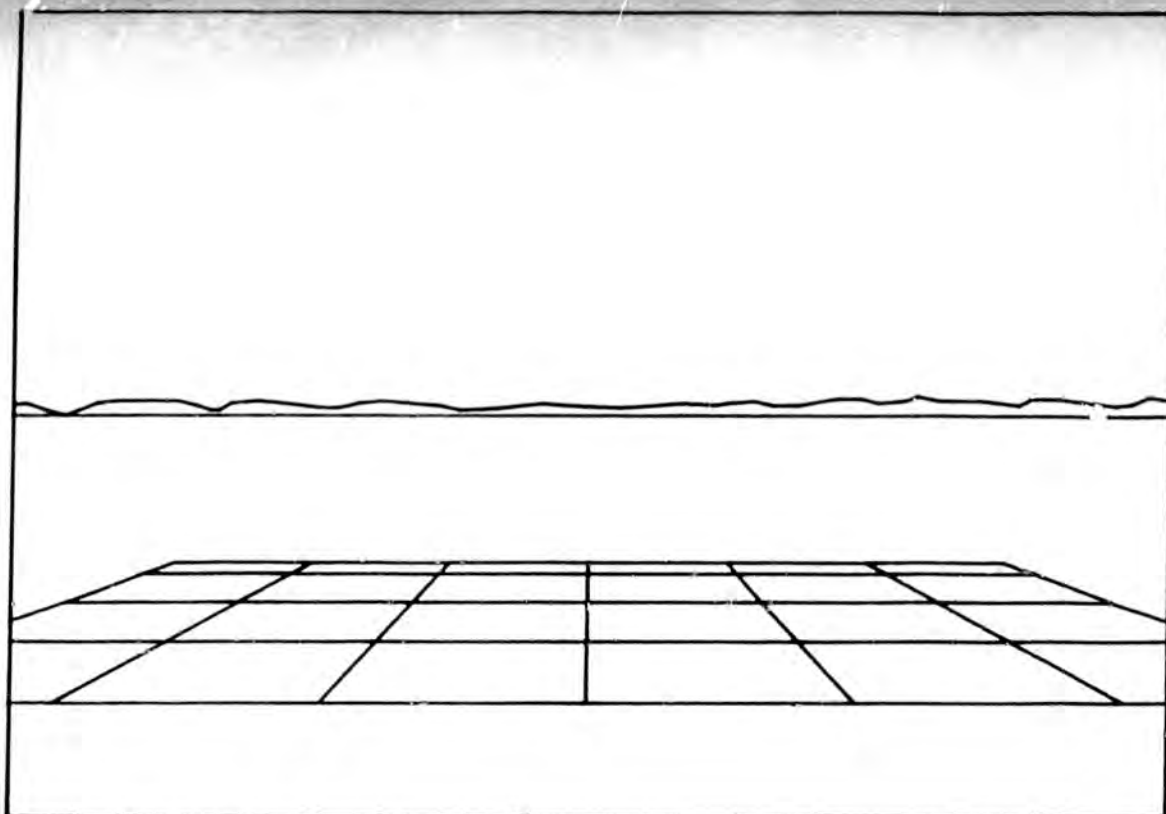
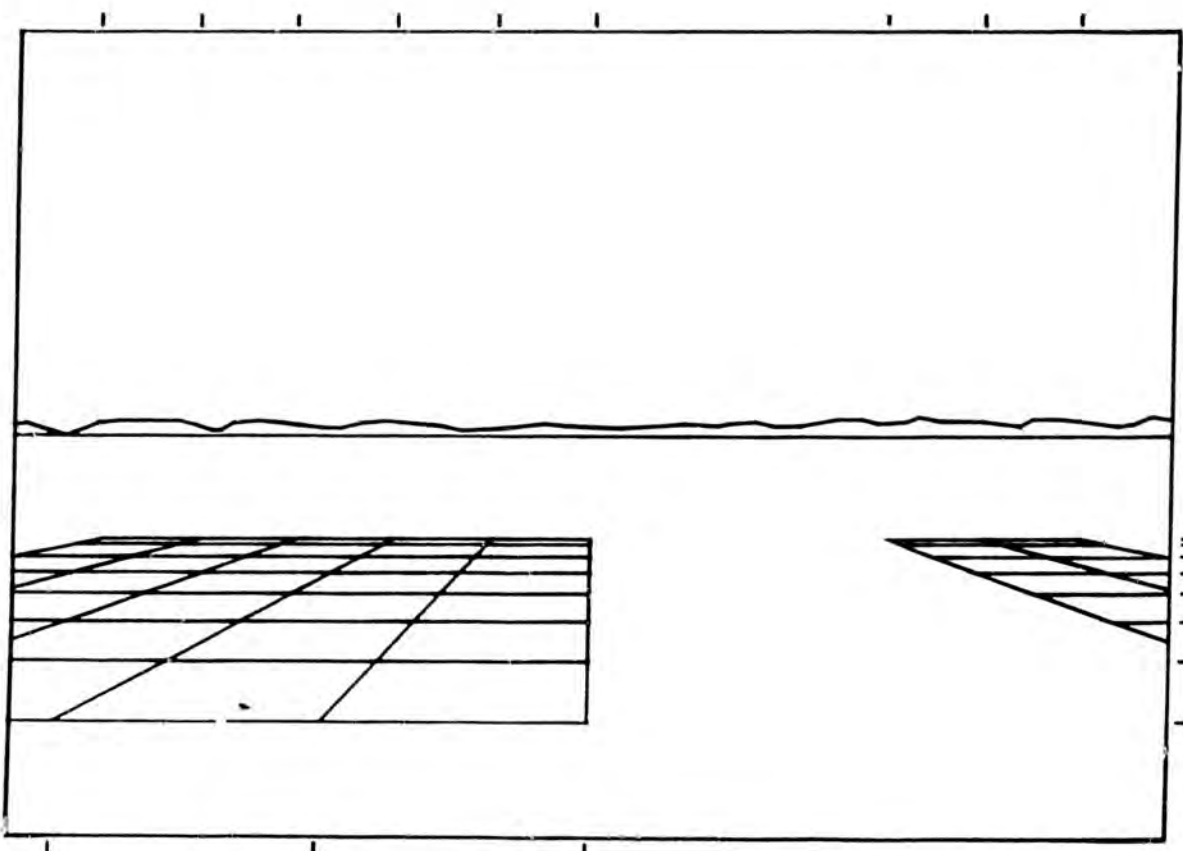


Figure 12. Routes by which an application for aquaculture is dealt with (a) by the County Administration in accordance with the Environmental Protection Act, and (b) by the Swedish National Board of Fisheries in accordance with the Fisheries Act.

5. Excerpts from Washington State "Aquaculture Siting Study"



5 Acres 100 ft. Grid



(2 Adjacent Projects)

7.5 and 3 Acres 100' Grid

Distance Offshore: 300 ft.

Observer Position: 105 ft. Above Sealevel

Typical Aquaculture Facility

Figure 1 Computer Simulation - View 4

AQUACULTURE VISUAL IMPACT ANALYSIS

		sensitivity level/visibility						
		High Sensitivity High Visibility	High Sensitivity Moderate Visibility	High Sensitivity Low Visibility	Moderate Sensitivity High Visibility	Moderate Sensitivity Moderate Visibility	Moderate Sensitivity Low Visibility	Low Sensitivity Any Visibility Category
scenic quality	Wilderness Areas	I	I	I	I	I	I	I
	HIGH	II	II	III	III	III	III	III
	MODERATE	II	III	III	III	III	IV	IV
	LOW	III	III	III	III	III	IV	IV

Visual Impact Classifications:

Class I (Wilderness Areas) - Severe Visual Impact

Any permanently visible aquaculture facility will likely have a severe visual impact that cannot be mitigated.

Class II - High Visual Impact

Areas where permanently visible aquaculture facilities will likely be visually obtrusive. To mitigate impact, project scale should be small enough not to call attention to itself or be located so not to be visually evident from key viewing points. Project design should borrow from the colors of the natural setting.

Class III - Moderate Visual Impact

Areas where permanently visible aquaculture facilities will be visually evident. To mitigate impact, project should remain visually subordinate to the project setting. Project design should borrow from the colors of the natural setting. Scale should be small enough so not to cover more than 10% of the cone of vision as seen from key observation points.

Class IV - Low Visual Impact

Areas where existing visual disruptions dominate (Industrial Landscapes); or areas of low sensitivity / Visibility. Most aquaculture facilities are unlikely to have an adverse visual effect. Few, if any, mitigation measures are necessary.

6. Washington State Shoreline Management Act of 1971
(excerpts); Coastal Zone Management Act of 1972
(U.S./Federal excerpts)

Chapter 90.58 RCW

SHORELINE MANAGEMENT ACT OF 1971

Sections			
90.58.010	Short title	90.58.290	Restrictions as affecting fair market value of property.
90.58.020	Legislative findings—State policy enunciated—Use preference.	90.58.300	Department as regulating state agency—Special authority.
90.58.030	Definitions and concepts.	90.58.310	Designation of shorelines of state-wide significance by legislature—Recommendation by director, procedure.
90.58.040	Program applicable to shorelines of the state.	90.58.320	Height limitation respecting permits.
90.58.050	Program as cooperative between local government and state—Responsibilities differentiated.	90.58.330	Study of shorelines of cities and towns submitted to legislature—Scope.
90.58.060	Timetable for adoption of initial guidelines—Public hearings, notice of.	90.58.340	Use policies for land adjacent to shorelines, development of.
90.58.070	Local governments to submit letters of intent—Department to act upon failure of local government.	90.58.350	Nonapplication to treaty rights.
90.58.080	Timetable for local governments to complete shoreline inventories and master programs.	90.58.360	Existing requirements for permits, certificates, etc., not obviated.
90.58.090	Approval of master program or segments thereof, when—Departmental alternatives when shorelines of state-wide significance—Later adoption of master program supersedes departmental program.	90.58.500	Exemption from this chapter for emergency recovery operations from Mt. St. Helens eruption authorized—Compliance with objectives required—Sediment retention structure exempt from RCW 90.58.030(3)(c)—Expiration of section.
90.58.100	Programs as constituting use regulations—Duties when preparing programs and amendments thereto—Program contents.	90.58.550	Oil or natural gas exploration in marine waters—Definitions—Application for permit—Requirements—Review—Enforcement.
90.58.110	Development of program within two or more adjacent local government jurisdictions—Development of program in segments, when.	90.58.560	Oil or natural gas exploration—Violations of RCW 90.58.550—Penalty—Appeal.
90.58.120	Adoption of rules, programs, etc., subject to RCW 34.04.025—Public hearings, notice of—Public inspection after approval or adoption.	90.58.900	Liberal construction—1971 ex.s. c 286.
90.58.130	Involvement of all persons and entities having interest, means.	90.58.910	Severability—1971 ex.s. c 286.
90.58.140	Development permits—Grounds for granting—Administration by local government, conditions—Applications—Notices—Rescission—When permits not required—Approval when permit for variance or conditional use.	90.58.911	Severability—1983 c 138.
90.58.145	Substantial development permit—Structures at temporary ferry terminals—Hood Canal bridge—Removal of structures.	90.58.920	Effective date—1971 ex.s. c 286.
90.58.150	Selective commercial timber cutting, when.	90.58.930	Referendum to the people—1971 ex.s. c 286—Determining if act continues in force and effect.
90.58.160	Prohibition against surface drilling for oil or gas, where.		
90.58.170	Shorelines hearings board—Established—Members—Chairman—Quorum for decision—Expenses of members.		
90.58.175	Rules and regulations.		
90.58.180	Appeals from granting, denying, or rescinding permits, procedure—Board to act, when—Local government appeals to board—Grounds for declaring rule, regulation, or guideline invalid—Appeals to court, procedure.		
90.58.190	Review and adjustments to master programs.		
90.58.200	Rules and regulations.		
90.58.210	Court actions to insure against conflicting uses and to enforce—Civil penalty—Review.		
90.58.220	General penalty.		
90.58.230	Violators liable for damages resulting from violation—Attorney's fees and costs.		
90.58.240	Additional authority granted department and local governments.		
90.58.250	Department to cooperate with local governments—Grants for development of master programs.		
90.58.260	State to represent its interest before federal agencies, interstate agencies and courts.		
90.58.270	Nonapplication to certain structures, docks, developments, etc., placed in navigable waters—Nonapplication to certain rights of action, authority.		
90.58.280	Application to all state agencies, counties, public and municipal corporations.		

Marine oil pollution -- Baseline study program: RCW 43.21A.405 through 43.21A.420.

RCW 90.58.010 Short title. This chapter shall be known and may be cited as the "Shoreline Management Act of 1971". [1971 ex.s. c 286 § 1.]

RCW 90.58.020 Legislative findings—State policy enunciated—Use preference. The legislature finds that the shorelines of the state are among the most valuable and fragile of its natural resources and that there is great concern throughout the state relating to their utilization, protection, restoration, and preservation. In addition it finds that ever increasing pressures of additional uses are being placed on the shorelines necessitating increased coordination in the management and development of the shorelines of the state. The legislature further finds that much of the shorelines of the state and the uplands adjacent thereto are in private ownership; that unrestricted construction on the privately owned or publicly owned shorelines of the state is not in the best public interest; and therefore, coordinated planning is necessary in order to protect the public interest associated with the shorelines of the state while, at the same time, recognizing and protecting private property rights consistent with the public interest. There is, therefore, a clear and urgent demand for a planned, rational, and concerted effort, jointly performed by federal, state, and local governments, to prevent the inherent harm in an

uncoordinated and piecemeal development of the state's shorelines.

It is the policy of the state to provide for the management of the shorelines of the state by planning for and fostering all reasonable and appropriate uses. This policy is designed to insure the development of these shorelines in a manner which, while allowing for limited reduction of rights of the public in the navigable waters, will promote and enhance the public interest. This policy contemplates protecting against adverse effects to the public health, the land and its vegetation and wildlife, and the waters of the state and their aquatic life, while protecting generally public rights of navigation and corollary rights incidental thereto.

The legislature declares that the interest of all of the people shall be paramount in the management of shorelines of state wide significance. The department, in adopting guidelines for shorelines of state wide significance, and local government, in developing master programs for shorelines of state wide significance, shall give preference to uses in the following order of preference which:

- (1) Recognize and protect the state-wide interest over local interest;
- (2) Preserve the natural character of the shoreline;
- (3) Result in long term over short term benefit;
- (4) Protect the resources and ecology of the shoreline;
- (5) Increase public access to publicly owned areas of the shorelines;
- (6) Increase recreational opportunities for the public in the shoreline;
- (7) Provide for any other element as defined in RCW 90.58.100 deemed appropriate or necessary.

In the implementation of this policy the public's opportunity to enjoy the physical and aesthetic qualities of natural shorelines of the state shall be preserved to the greatest extent feasible consistent with the overall best interest of the state and the people generally. To this end uses shall be preferred which are consistent with control of pollution and prevention of damage to the natural environment, or are unique to or dependent upon use of the state's shoreline. Alterations of the natural condition of the shorelines of the state, in those limited instances when authorized, shall be given priority for single family residences, ports, shoreline recreational uses including but not limited to parks, marinas, piers, and other improvements facilitating public access to shorelines of the state, industrial and commercial developments which are particularly dependent on their location on or use of the shorelines of the state and other development that will provide an opportunity for substantial numbers of the people to enjoy the shorelines of the state. Alterations of the natural condition of the shorelines and wetlands of the state shall be recognized by the department. Shorelines and wetlands of the state shall be appropriately classified and these classifications shall be revised when circumstances warrant regardless of whether the change in circumstances occurs through man-made causes or natural causes. Any areas resulting from alterations of the natural condition of the shorelines and wetlands of the state no longer meeting the definition of "shorelines

of the state" shall not be subject to the provisions of chapter 90.58 RCW.

Permitted uses in the shorelines of the state shall be designed and conducted in a manner to minimize, insofar as practical, any resultant damage to the ecology and environment of the shoreline area and any interference with the public's use of the water. [1982 1st ex.s. c 13 § 1; 1971 ex.s. c 286 § 2.]

RCW 90.58.030 Definitions and concepts. As used in this chapter, unless the context otherwise requires, the following definitions and concepts apply:

(1) Administration:

(a) "Department" means the department of ecology;

(b) "Director" means the director of the department of ecology;

(c) "Local government" means any county, incorporated city, or town which contains within its boundaries any lands or waters subject to this chapter;

(d) "Person" means an individual, partnership, corporation, association, organization, cooperative, public or municipal corporation, or agency of the state or local governmental unit however designated;

(e) "Hearing board" means the shoreline hearings board established by this chapter.

(2) Geographical:

(a) "Extreme low tide" means the lowest line on the land reached by a receding tide;

(b) "Ordinary high water mark" on all lakes, streams, and tidal water is that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department: *Provided*, That in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water;

(c) "Shorelines of the state" are the total of all "shorelines" and "shorelines of state-wide significance" within the state;

(d) "Shorelines" means all of the water areas of the state, including reservoirs, and their associated wetlands, together with the lands underlying them; except (i) shorelines of state-wide significance; (ii) shorelines on segments of streams upstream of a point where the mean annual flow is twenty cubic feet per second or less and the wetlands associated with such upstream segments; and (iii) shorelines on lakes less than twenty acres in size and wetlands associated with such small lakes;

(e) "Shorelines of state-wide significance" means the following shorelines of the state:

(i) The area between the ordinary high water mark and the western boundary of the state from Cape Disappointment on the south to Cape Flattery on the north, including harbors, bays, estuaries, and inlets;

COASTAL ZONE MANAGEMENT ACT OF 1972

(PL 92-583, 16 U.S.C. 1451 *et seq.*, October 27, 1972; Amended by PL 93-612, January 2, 1975; PL 94-370, July 26, 1976; PL 95-219, December 28, 1977; PL 95-372, September 18, 1978; PL 96-464, October 17, 1980; PL 98-620, November 11, 1984; PL 99-272, April 7, 1986)

SHORT TITLE

SEC. 301. This title may be cited as the "Coastal Zone Management Act of 1972".

CONGRESSIONAL FINDINGS

SEC. 302. The Congress finds that —

(a) There is a national interest in the effective management, beneficial use, protection, and development of the coastal zone.

(b) The coastal zone is rich in a variety of natural, commercial, recreational, ecological, industrial, and esthetic resources of immediate and potential value to the present and future well-being of the Nation.

(c) The increasing and competing demands upon the lands and waters of our coastal zone occasioned by population growth and economic development, including requirements for industry, commerce, residential development, recreation, extraction of mineral resources and fossil fuels, transportation and navigation, waste disposal, and harvesting of fish, shellfish, and other living marine resources, have resulted in the loss of living marine resources, wildlife, nutrient-rich areas, permanent and adverse changes to ecological systems, decreasing open space for public use, and shoreline erosion.

(d) The coastal zone, and the fish, shellfish, other living marine resources, and wildlife therein, are ecologically fragile and consequently extremely vulnerable to destruction by man's alterations.

(e) Important ecological, cultural, historic, and esthetic values in the coastal zone which are essential to the well-being of all citizens are being irretrievably damaged or lost.

[302(f) added by PL 96-464]

(f) New and expanding demands for food, energy, minerals, defense needs, recreation, waste disposal, transportation, and industrial activities in the Great

Lakes, territorial sea, and Outer Continental Shelf are placing stress on these areas and are creating the need for resolution of serious conflicts among important and competing uses and values in coastal and ocean waters. [Former 302(f)—(i) redesignated as (g)—(j) by PL 96-464]

(g) Special natural and scenic characteristics are being damaged by ill-planned development that threatens these values.

(h) In light of competing demands and the urgent need to protect and to give high priority to natural systems in the coastal zone, present state and local institutional arrangements for planning and regulating land and water uses in such areas are inadequate.

(i) The key to more effective protection and use of the land and water resources of the coastal zone is to encourage the states to exercise their full authority over the lands and waters in the coastal zone by assisting the states, in cooperation with Federal and local governments and other vitally affected interests, in developing land and water use programs for the coastal zone, including unified policies, criteria, standards, methods, and processes for dealing with land and water use decisions of more than local significance.

(j) The national objective of attaining a greater degree of energy self-sufficiency would be advanced by providing Federal financial assistance to meet state and local needs resulting from new or expanded energy activity in or affecting the coastal zone.

CONGRESSIONAL DECLARATION OF POLICY

SEC. 303. The Congress finds and declares that it is the national policy—

(1) to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations;

(2) to encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and esthetic values as well as to needs for economic development, which programs should at least provide for—

(A) the protection of natural resources, including wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat, within the coastal zone,

(B) the management of coastal development to minimize the loss of life and property caused by improper development in flood-prone, storm surge, geological hazard, and erosion-prone areas and in areas of subsidence and saltwater intrusion, and by the destruction of natural protective features such as beaches, dunes, wetlands, and barrier islands.

(C) priority consideration being given to coastal-dependent uses and orderly processes for siting major facilities related to national defense, energy, fisheries development, recreation, ports and transportation, and the location, to the maximum extent practicable, of new commercial and industrial developments in or adjacent to areas where such development already exists,

(D) public access to the coasts for recreation purposes,

(E) assistance in the redevelopment of deteriorating urban waterfronts and ports, and sensitive preservation and restoration of historic, cultural, and esthetic coastal features,

(F) the coordination and simplification of procedures in order to ensure expedited governmental decision-making for the management of coastal resources,

(G) continued consultation and coordination with, and the giving of adequate consideration to the views of, affected Federal agencies,

(H) the giving of timely and effective notification of, and opportunities for public and local government participation in, coastal management decisionmaking, and

(I) assistance to support comprehensive planning, conservation, and management for living marine resources, including planning for the siting of pollution control and aquaculture facilities within the coastal zone, and improved coordination between State and Federal coastal zone management agencies and State and wildlife agencies; and

(3) to encourage the preparation of special area management plans which provide for increased specificity in protecting significant natural resources, reasonable coastal-dependent economic growth, improved protection

of life and property in hazardous areas, and improved predictability in governmental decisionmaking; and

(4) to encourage the participation and cooperation of the public, state and local governments, and interstate and other regional agencies, as well as of the Federal agencies having programs affecting the coastal zone, in carrying out the purposes of this title.

[303 revised by PL 96-464]

DEFINITIONS

SEC. 304. For the purposes of this title —

(1) The term "coastal zone" means the coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shorelines of the several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends, in Great Lakes waters, to the international boundary between the United States and Canada and, in other areas, seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers or agents.

[304(2) added by PL 96-464]

(2) The term "coastal resource of national significance" means any coastal wetland, beach, dune, barrier island, reef, estuary, or fish and wildlife habitat, if any such area is determined by a coastal state to be of substantial biological or natural storm protective value. [Former 304(2)—(16) redesignated as (3)—(17) by PL 96-464]

(3) The term "coastal waters" means (A) in the Great Lakes area, the waters within the territorial jurisdiction of the United States consisting of the Great Lakes, their connecting waters, harbors, roadsteads, and estuary-type areas such as bays, shallows, and marshes and (B) in other areas, those waters, adjacent to the shorelines, which contain a measurable quantity or percentage of sea water, including, but not limited to, sounds, bays, lagoons, bayous, ponds, and estuaries.

(4) The term "coastal state" means a state of the United States in, or bordering on, the Atlantic, Pacific, or Arctic Ocean, the Gulf of Mexico, Long Island Sound, or one or more of the Great Lakes. For the purposes of this title, the term also includes Puerto Rico, the Virgin Islands, Guam, the Commonwealth of the Northern

7. Etolin Island area Mariculture Pilot Project final report, re coastal use conflict and siting guidelines.

Alaska Coastal Zone Management Program (excerpts from statute); Alaska Coastal Zone Management Program - 1986 Annual Report (excerpts)

CONFLICTS WITH OTHER COASTAL USERS

Mariculture is a relatively new industry in Alaska and has potential to conflict with established uses. Many existing uses are dispersed over large areas while other activities likely to produce pollution are localized. These conditions provide opportunities to site mariculture facilities to avoid conflict with other users. Not all conflicts can be resolved, but most can.

Resource agencies in Alaska sometimes lack detailed information on all uses occurring in Alaska's vast coastal areas. Use patterns can be dynamic, varying dramatically in response to changes in natural conditions and government regulations. Resource agencies conduct planning and permit review processes to provide opportunities for existing and potential resource users to identify their needs.

Stringent water quality standards for growth of marketable seafood products will limit the suitability of sites to those physically located separate from areas with waste discharges. Determining acceptable separation distances will help guide any conflict resolution process and will determine areas where mariculture and other uses are incompatible.

This section will discuss major conflicts with other users of Alaska's coastal resources.

Land Management Issues

Resource agencies share responsibilities for development of new industries that depend on public resources for development. Primary land use manager for the state is the Department of Natural Resources (DNR). DNR is responsible for developing these resources while at the same time providing for resource conservation and protection.

DNR historically has been the state agency facing new industries needing access and use of state land, such as prospective barley farms, coal mines, petrochemical plants, shore based seafood processing facilities, geothermal

energy developments, and cattle ranching. Developers need assurance of long term property rights to secure financing and so they don't lose control of sites in which they have made significant capital investments. DNR's responsibility is to ensure that commitment of state lands will be lawful, in the public's best interest and will produce viable new industries, useful products, stable jobs, and hopefully a fair market value.

Other resource agencies such as ADF&G and DEC review development proposals under their statutory authorities and also provide guidance to DNR for development and protection of resources in their areas of responsibility. These agencies and others share in the Alaska Coastal Management Program (ACMP) which provides for a coordinated review of all coastal development in Alaska.

Aquatic farming may become a significant long term use of state tide and submerged lands. Alaska must achieve balance in its regulatory programs which will allow this industry to thrive, while at the same time protecting existing uses of land. Problems that may occur if balance is not achieved include displacement of public uses such as recreation and fish and wildlife harvest, conflicts with other commercial uses of tide and submerged lands, land speculation, impacts on adjacent land holders, and stifling of an emerging industry.

Mariculture Development Land Use Needs

Successful mariculture developments share a number of basic requirements. Foremost among these is a need to secure appropriate sites. Desirable features of a mariculture site are also often desirable for other uses, such as anchorages. Even in rural Alaska, it is a rare mariculture site that does not also attract other users.

Resolution of use conflict usually involves two approaches:

1. Separating uses geographically. Competing uses can often be separated to avoid conflicts.
2. Mitigating measures, such as site design, timing restrictions on use, or access corridor stipulations may allow more than one use of a site and resolve conflict.

Unfortunately, not all conflicts can be resolved to allow multiple use of the same site. It is then the land managers responsibility to determine best use of state lands. Such conflicts are more likely to occur in areas not covered by an appropriate land use plan. Experience has been, however, that many conflicts can be resolved using the State's coastal management program project consistency review system. This system has been developed and refined by state agencies over many years of permit review and conflict resolution.

Displacement of Public Use

Structures on tidelands can physically displace or obstruct other uses requiring surface access. Mariculturists sometimes apply for use of areas larger than the physical dimensions of proposed structures (see Table 3-3) to minimize impacts to their operations from other human activities. Physical displacement can exist for farm site as well as for upland facilities. This may affect an even larger area if other human activities require a degree of solitude.

Culture technique is one variable determining if displacement will occur, and the magnitude of physical displacement. Bottom culture and submerged structures have least impact on natural resource harvest, boating and on aesthetic enjoyment, but may displace fish and wildlife harvests of bottom dwelling species such as crab and clams.

Both longlines and rafts can interfere with recreational and commercial harvest ac-

tivities. While longlines require only surface floats, in contrast to log boom structures commonly used as rafts, very extensive longline grids are used in other countries such as Japan (see Table 3-4).

Floating culture of shellfish and seaweed are commonly kept separate through negotiation in other countries. Japanese, fishing cooperatives allocate uses, prohibiting fishing boats and nets in areas of seaweed culture, (Olson, 1987) and prohibiting suspended culture in nearshore areas where fishing rights are maintained over bottom culture areas (Ito et. al., 1975).

Aesthetic conflicts are less tangible than physical displacement. Longlines may be less objectionable than rafts in terms of their visibility, however some people object to floating structures in front of recreational homes or cabins, and to associated activities and noise resulting from mariculture operations. Aesthetic objections from recreational home owners have been an issue in New Zealand (Dias 1984), in Washington (Freeman, 1985; E. Hurlburt, pers. comm., 1988), and in British Columbia (Butler, 1986).

Recreation

Expectations and desires for seclusion when recreating in rural Alaska is highly valued by residents and visitors. A mariculture facility, particularly with caretaker facilities located in a smaller cove, will essentially eliminate that sense of seclusion for recreation users. Those recreation users tend to find other secluded and aesthetically pleasing areas. Coastal resources may receive competing uses in many areas. Degree and intensity of recreation pursuits are difficult to define and may be dynamic in nature. Rural coastal areas receive dispersed recreation activities by small groups or individuals at widespread and diverse sites.

Mariculture development has the potential to block or inhibit public access to coastal recreation areas. The ACMP recreation standard requires state agencies to give high priority to

maintaining public access to coastal waters. Mariculture operations that would form a barrier between coastal waters and shorelines, or that would prohibit access to important coastal areas, could be found inconsistent with ACMP requirements.

Anchorage

Potential conflicts exist between anchorages and mariculture development. Mariculture sites need room for floats, rafts and other waterborne structures. They also need pristine waters free from high coliform counts and other forms of pollutants. Some organisms and growing facilities are adversely affected by waves from boat wakes.

Boats need room to maneuver and anchor. Some boats inadvertently discharge waste products into water. Some boat operators may ignore sound waste management procedures and choose to discharge contaminants at will. Not all boat harbors in Southeast Alaska have adequate holding tank pumping stations available making it difficult for even conscientious boaters to comply.

Raw sewage means contamination of marine organisms by coliforms. Waste products such as chlorine used by some boats to flush sewage tanks and bilges are highly toxic to mariculture organisms. Heavy metals associated with fuel and oil wastes are readily absorbed and held by many species of sea vegetables.

Current information indicates large, heavily used anchorages, or small, strategically located anchorages and mariculture facilities are incompatible. Sewage, chlorine from sewage systems, diesel, oils or other waste products discharged from boats near a mariculture facility may result in unacceptably high coliform counts or other forms of pollution. Infrequent boat activity, that does not discharge harmful products into the water is not a major problem.

This situation could be improved by the compliance by all boats holding sewage and waste products for acceptable disposal. Develop-

ment of dumping facilities in more commercial harbors may also help to alleviate sewage problems.

Proposals for mariculture sites proposed in known anchorages should include alternate anchorages nearby. High use anchorages with no nearby alternative anchorages will have difficulty being permitted or leased for mariculture sites. Smaller, secondary anchorages with alternate anchorages nearby will probably be more successful in obtaining necessary authorizations.

Mitigating measures for this conflict usually means locating the two facilities far enough apart so there is no conflict. Another potential mitigating measure might be adoption of a "relay" system. Under this system shellfish are taken from contaminated or polluted areas to noncontaminated waters. Shellfish are held for a minimum of two weeks to cleanse themselves. Testing indicates when the acceptable product is released for sale. Actual time for this cleansing process may be considerably more than two weeks.

Relaying has not been tried in Alaska. It may require substantial handling and facilities that would add to the cost of products. Further testing would be needed if this system is considered.

Fish and Wildlife Harvest

Recently passed legislation requires that regulations must provide for the consideration of upland management policies and whether the proposed use of a site is compatible with the traditional and existing uses of the area in which the site is located. Both longline and raft culture techniques involve structures that can interfere with commercial and noncommercial harvest of fish and wildlife. Longlines require only floats on the surface, in contrast to log boom structures commonly used as rafts. Extensive longline grids are in use in other countries. (See table 3-4)

Conflicts between mariculture structures and other uses depend partly on if the farmer needs to restrict boat traffic. For example, farmers may wish to limit boat traffic to minimize potential for vandalism and pollution from fuel and sewage. Conversely, personal use crab fisheries may be very productive around rafts used for culturing sea organisms.

Because communities that use the study area are currently considered subsistence communities, subsistence harvests are important activities in most areas where aquatic farming may occur. Conflicts between mariculturists and subsistence users could occur as more facilities are developed. Development of direct competition for subsistence resources may increase as new residents enter rural areas. Loss of subsistence opportunities could occur if mariculture facilities are placed in important subsistence resource areas.

Results of a subsistence study currently being conducted by ADF&G, Division of Subsistence will be helpful in identifying potential conflicts.

Conflicts with Other Commercial Uses of Tidelands and Submerged Lands

The best sites for aquatic farm facilities may often be the best sites for other uses such as mineral or timber transfer and support facilities, log storage, commercial fishing grounds, anchorages, or commercial recreation development. Although mariculture is a new industry in Alaska, some conflicts have surfaced in Kodiak, Prince William Sound, and Southeast. Besides need for space, water quality standards for mariculture may preclude use of favored sites for other commercial or industrial facilities. Forcing more stringent mitigation measures or alternative siting for timber, mineral transfer, or tailings disposal could reduce or eliminate economic viability of resource extraction industries in a given area.

Conversely, mineral or timber transfer sites, log storage sites, and floating camps as-

sociated with resource development activities may limit space available or degrade water quality for mariculture facilities, making mariculture development more difficult and less likely.

Commercial Fishing

In the study area, commercial fishing seldom occurs in secluded coves and bays that are more commonly suitable for mariculture. Nevertheless, these protected coves may be important to the commercial fishing fleet because they provide safe anchorages close to fishing grounds or tenders.

Potential conflicts may develop due to fishing hook-off points. These are locations near shore where commercial fishing nets are set for harvest of fish. Hook-off points can occur virtually anywhere along shorelines free of rocks or other obstacles that would tangle nets. Some hook-off points are valuable sites for fishing boats as fish migration patterns bring them to the same area year after year. Culture techniques utilized by mariculture operations that restrict use of open shorelines have the potential to conflict with hook-off points.

Conflicts may be limited to those times of year fish harvest occurs. Separation of uses may be the only practical solution to this type of conflict.

Commercial Recreation

Commercial recreation in the form of hunting, fishing, and guiding, or the establishment of recreation lodges have potential for conflict with mariculture development. Aside from potential physical displacement, such recreation development could provide sources of point pollution.

Type and degree of conflict can only be determined on a case by case basis.

Logging

Conflicts with timber harvest operations may occur because floating facilities can interfere with log transfer and floating storage operations. In the study area, timber harvest on Forest Service lands is continuing, and operations require log transfer at tidewater, storage of log rafts in protected bays and inlets, and towing rafts to mills. Conflicts may arise because of: 1) the overlap of many siting and operational requirements for log transfer and storage and for mariculture, particularly a requirement for protected waters, and 2) the potential for degradation of water quality in the vicinity of log transfer facilities.

Log transfer and storage area siting involves a detailed review of potential environmental impacts and conflicts with other uses. Suitable sites which meet environmental and industry criteria are generally limited in number. Unless mariculture, log transfer and storage can coexist, there may be direct competition for sites.

Bark and other organic debris resulting from log transfer and storage can have adverse impacts similar in nature to those associated with floating mariculture facilities (Pacific Northwest Pollution Control Council, 1971; Pease, 1974; Schultz and Berg, 1976; Duval and Slaney Co., 1980). Anaerobic sediments can form and hydrogen sulphide may be released. Freese and O'Clair (1984) documented a relationship between low dissolved oxygen concentrations, high hydrogen sulphide and ammonia concentrations, and mortality in mussels and littleneck clams exposed to decomposing wood wastes under laboratory conditions. Decomposition of log wastes can also release leachate which are toxic to some species of shellfish (Buchanan et al., 1976).

Close proximity of log transfer facilities and floating mariculture facilities in small or poorly flushed waterbodies could result in contamination, disease, or mortality of cultured animals. Bottom culture should be precluded in areas where large quantities of bark could potentially be deposited. Intertidal storage

and upland support facilities should be located to minimize potential problems.

Other types of water quality conflicts may also occur. Use of pesticides at dry land log storage sites has been proposed in Alaska (e.g., the use of lindane mixed in diesel oil to control ambrosia beetle at Thorne Bay in 1983). These substances can bio-accumulate in shellfish. Requirements for boat and seaplane traffic for timber harvest and transfer operations also increase the potential for hydrocarbon pollution. Sewage discharge from logging facilities would be of concern as a possible point source of pollution. Logs are sometimes lost and floating debris could damage mariculture structures.

No known mitigating measures exist that could increase compatibility. Distances between TTF's and mariculture sites are determined largely on a case by case basis due to currents and other physical characteristics of the area in question.

Mining

Potential conflicts in the form of direct competition for suitable sites for mineral transfer and mariculture are similar in nature as those between mariculture and logging activities. Remote hardrock mine sites require upland facilities for processing ore, transfer facility operations, and for loading barges transporting ore to markets. Options for siting mariculture facilities in close proximity to mine sites are limited. Water quality impacts can result from mining operations. Disposal of tailings in marine waters that contain high concentrations of heavy metals or result in high levels of turbidity and suspended sediments are inherent conflicts. The potential for water pollution from sewage discharge, boat fuel hydrocarbons, and waste oil is similar to that for logging support facilities and operations.

Urban Development

Industrial and commercial development of shorelines may conflict with requirements of mariculture developments through physical competition for space or through a variety of pollution sources. Degree and type of impact is site specific.

The U.S. Forest Service manages most lands in the study area. No urban development is planned at this time.

Residential Development

Residential development along shorelines or floathomes can compete for physical space with mariculture facilities. Residential development can also result in point source discharge of sewage. Shoreline residents can object to mariculture on aesthetic grounds. One subdivision, Olive Cove, exists in the study area with both private and state ownership. Conflicts between mariculture facilities and residential development may be minimal. However, public and agency review should address these potential concerns if mariculture development is proposed in this area.

Historic or Archeological Sites

Upland development associated with mariculture is not compatible with historic or archeological sites. By law, these sites must not be affected or, as a last resort, extensive mitigation is required to identify and record values before impact occurs.

Because of limited surveys of variable intensity, all historical and archeological sites have not been located within the study area. Location of known sites will not be provided in an attempt to prevent vandalism.

If a U.S. Forest Service Special Use Permit is required, applicants must initiate a site survey by a qualified archeologist. The Special Use Permit will normally be denied when historic or archeological values are found on or adjacent to the requested site. State permits

may similarly require extensive mitigation or be subject to denial on these grounds.

Land Speculation

Prior to 1986, British Columbia experienced a dramatic rush for permits which allowed the holder to enter and occupy a site to conduct research for up to one year. It appears that these permits were being issued for large areas of land with little regard for potential impacts to the public. A gold rush image was created resulting in a great deal of public concern, and subsequently a moratorium was imposed. Alaska does not have an investigative permit similar to this permit but we could experience land speculation in other forms, most notably by applying for permits and leases to tie up a site.

Land speculation in this case is described as obtaining land use rights with the intent of not using the land for proposed uses but selling or trading those rights for a profit. This problem is not unique to mariculture and can occur in any use of state land. Speculation can be greatly reduced by close monitoring of development schedules and writing conditions in land use documents that would allow agencies to revoke permits or leases if the development is not proceeding as proposed.

Impacts on Adjacent Land Owners

Mariculture can impact adjacent land owners in a variety of ways: loss of tidelands access or boat moorage, loss of view, noise, loss of privacy, loss of habitat, and changes in water quality. This has been a significant issue in Washington and British Columbia, and may become a concern in Alaska.

Adjacent land owners have a number of ways to participate in mariculture facility siting. They can participate in development of state land use plans, coastal zone management programs, and local comprehensive plans. Adjacent owners are notified by mail of pend-

ing applications and are given an opportunity to comment on projects. A 30 day public notice pursuant to AS 38.05.945 is required for leases. Local governments, regional or village native corporations, local coastal districts, and communities are also notified. Local government or regional native corporations may hold public hearings if necessary. Department of Natural Resources reviews all of these comments and weighs the use and enjoyment of the adjacent owner against what is considered to be state's best interest.

Land use conflicts on uplands are adjudicated in the study area by Forest Service officials utilizing the Tongass Land Management Plan.

Upland Access

Access is a major consideration under current permit and lease review processes. A part of the state's "best interest" determination is an evaluation of impacts on access, especially to upland owners. Access is important for recreation and fish and wildlife harvest on public lands. Access by water craft, aircraft and in some circumstances by land vehicle can occur.

In most circumstances, access problems can be mitigated on a mariculture site by specification of easements or access corridors on permits or leases. In some circumstances there is not sufficient room to separate two uses. In these cases access may be allowed over other forms of development if a reasonable alternative cannot be found.

U.S. Forest Service as Upland Managers

As primary managers of uplands in the study area, the U.S. Forest Service has the responsibility of management of upland permits for mariculture development. Land use designation (LUD) I, II, III, and IV of Tongass Land Management Plan provides guidance for development in Tongass National Forest.

Following is a brief description of the four major land use designations for Forest Service lands:

LUD I (and LUD I Release Areas) - This designation is primarily a wilderness designation. It provides for minimal development compatible with maintenance of natural character of land.

LUD II - This designation is managed in a roadless state to retain its wildland character but would permit wildlife and fish habitat improvement and primitive recreational development. (The study area contains no LUD II lands)

LUD III - This land is managed for a variety of uses. Emphasis is on managing for uses and activities in a compatible and complementary manner to provide the greatest combination of benefits. These areas have either high use or high amenity values in conjunction with high commodity values.

LUD IV - This area will be managed to provide opportunities for intensive resource use and development where emphasis is primarily on commodity or market resources.

The southern half of Etolin Island is currently designated as LUD I Release. These lands are being managed to provide opportunities for solitude and primitive types of recreation in unaltered environment.

Components of mariculture projects occurring above mean high tide line must be compatible with the goals of the LUD classifications. Development in LUD IV areas is more acceptable than within the LUD I Release area. Development in all LUD areas will be restricted to structures specifically designed to blend into surrounding landscape. Size, location, and color of structures and the amount of trees to be removed will be specified by the Forest Service for development in all LUD's. Although goals for TLMP do not apply to the waters below mean high tide the U.S. Forest Service expects permitted activities on water adjacent to the Forest will be compatible with management direction for surrounding uplands.

There is currently one Special Use Permit for an upland facility to support mariculture development in the LUD I Release area. No more permits will be issued unless the designation changes to LUD II, III, or IV.

The U.S. Forest Service is presently revising its land management plan for the Tongass National Forest including the Etolin Island area. Specific direction on how the resources on Etolin Island will be managed will appear in the plan. Until the revision is completed current Tongass Land Management Plan direction and guidelines will apply to mariculture developments.

Cumulative Effects of Expanding Tidelands Use

For most of coastal Alaska, mariculture facilities are permitted on an individual basis. Impact from one or two farms may be minimal, but cumulative effects of numerous farms on existing uses may be dramatic. DNR management and area plans provide a process for resolving use conflicts on a regional basis, and best interest findings required under AS 38.05.035(e) provide mechanisms for resolving conflicts on individual permits/leases. The ACMP consistency review process also provides a mechanism for resolving conflicts regarding use of state tide and submerged lands.

Although a regional perspective is preferred, cost of management and area plans limits their use as a routine method of sorting out

problems and resolving conflicts. Lack of a regional perspective could lead to significant conflicts over time and is a major problem with the existing process.

During development of statewide guidelines, Alaska could evaluate British Columbia experience during its initiation to finfish aquaculture. Immediate needs for coastal planning occurred when it became apparent that a loss of access, a loss of anchorages, impacts on upland owners, impacts on recreation, and tourism. British Columbia placed a moratorium on leases and licenses for finfish farming and began an inquiry into finfish aquaculture and its impacts. Inquiries were completed in 1986. How well their conclusions or recommendations apply to Alaska conditions is uncertain.

Summary

While numbers of potential problems are large, it appears most land use problems associated with mariculture can be resolved. Appropriate land use plans and permit review processes, such as ACMP consistency determinations, are useful to resource agencies to accomplish resolution of conflict. Developing comprehensive area plans is desirable but time consuming (2-3 years) and expensive. Refined policies and regulations are being developed from newer and more accurate information by all resource and review agencies. This will greatly assist land management agencies in resolving conflicts among coastal users.

GUIDELINES AND MITIGATING MEASURES

Relative Measures of Suitability

In developing a mariculture facility several factors need to be considered: 1) if the site is capable of commercial production, 2) if the site is able to meet requirements of facility design, and 3) if the development is an acceptable use of public land and water.

Interactions between factors are complex, and may fluctuate from season to season or from year to year. The economic environment may support development, or can contribute to failures. Other uses sometimes compete for limited resources.

The following discussions are presented to assist agencies or individuals in determining the suitability of a site for select species of shellfish or kelp. It is unlikely any single site will be the "million dollar" site in all respects. Therefore, these indicators will be helpful in estimating the relative suitability of mariculture sites.

Guidelines for Siting Shellfish and Sea Vegetable Mariculture Facilities and Mitigating Impacts

"Mitigation" is the process of avoiding or minimizing adverse impacts. Proper siting of shellfish and seaweed mariculture facilities should result in avoiding the majority of adverse impacts that might otherwise occur.

Conflict over mariculture siting has resulted in development of siting criteria and zoning in both Washington and British Columbia. In both areas, conflict has primarily been over finfish net pen siting. However, guidelines developed are in use for "all aquaculture proposals involving floating structures and improvements" in British Columbia (B.C. Ministry of Forestry and Lands 1987).

Proposed siting guidelines are based on a review of interim guidelines for management of salmon net pen culture in Puget Sound (Science Applications International Corporation 1986), on draft guidelines for development and operation of aquaculture and fish processing facilities (Department of Fisheries and Oceans Canada, Pacific Region 1986 a,b), and on siting guidelines developed by ADF&G for other forms of coastal development and by DNR for area plans.

Guidelines proposed here are based on several assumptions: 1) mariculture in the near future will be similar to that currently practiced (i.e., floating structures will be used, but bottom culture techniques may be proposed), 2) regardless of culture technique used, exclusive use of areas will be desired by farmers, 3) sites require expansion potential, 4) farms require potential for access to and use of adjacent uplands for support facilities and use of intertidal zone and beach above high tide for beaching gear, and storing or hardening shellfish. Some criteria are in conflict (e.g., increasing stocking density to reduce areal extent to minimize user conflicts vs. decreasing stocking density and increasing areal extent to minimize sedimentation impacts). Applicability of each guideline will depend on specific sites and proposal under review but they are included in this report as guidelines to both prospective sea farmer and to project reviewers.

Fish and wildlife concentration areas and human use areas described have been mapped as part of this project for the Etolin Island area.

Guidelines are organized into three phases: 1) siting, 2) project design, and 3) operations. If sites can be selected which avoid areas described under Siting Guidelines, then measures described in subsequent sections to mitigate impacts through design or operation may be unnecessary.

Siting Guidelines

1. To minimize adverse impacts on productive benthic habitats:

1a - Conduct a site survey to determine flushing regime, benthic community composition, and baseline water quality (i.e., dissolved oxygen levels, presence of toxicants or contaminants).

1b - Site floating facilities and intertidal structures where currents are strong enough to disperse suspended organics and organic deposits. Avoid siting in small embayments with sills, natural restrictions to tidal exchange, or existing water quality problems.

1c - Site floating facilities or structures embedded in the substrate in areas with least productive benthic habitat. Avoid shallow areas (less than 40 feet deep at Mean Lower Low Water).

1d - Because bottom culture site requirements are likely to conflict with maintenance of existing productive benthic communities, detailed site analysis including a dive survey should occur prior to siting. Bottom culture requirements should be defined. Information on the existing benthic community, proposed methods of reducing or eliminating predation, stocking rates, and potential effects on competing species should be provided. Feasibility of culture in alternative sites which have lower benthic productivity should be evaluated.

1e - Avoid siting within 300 feet of herring spawning areas, hard shell clam concentration areas, and eelgrass and kelp beds. Avoid siting sea vegetables farms within 300 feet of herring spawning areas and eelgrass beds.

1f - Select least productive intertidal or upland areas for activities involving dredging, fill, significant compaction of vegetation and sediments (e.g., filling or mechanized

access), or flow alterations. Avoid use of equipment in productive habitat, particularly tideflats and salt marshes.

1g - Do not allow floating structures to ground at any tidal stage, except for planned beaching of gear for cleaning or fouling control. Beach gear in the intertidal area or beach area of lowest biological productivity. Sand or gravel beaches are the preferred sites; avoid tideflats adjacent to streams and salt marshes.

2. To avoid disturbance of sensitive fish or wildlife species or species during sensitive life history stages:

2a - Avoid siting within 330 feet or within a distance determined by the U.S. Fish and Wildlife Service of bald eagle nests.

2b - Avoid siting within a 300 foot radius of mouths of anadromous fish streams at Mean Lower Low Water.

2c - Avoid siting within one mile of: 1) harbor seal haul out concentration areas or pupping areas, 2) sea otter concentration areas, pupping areas, or feeding areas, and 3) seabird colonies.

2d - Avoid siting within waterfowl and shorebird seasonal concentration areas.

These guideline distances can be modified on a site specific basis if other measures will mitigate the disturbance or if disturbance is determined to be insignificant.

3. To minimize the effect of creating an attractive nuisance to potential predators or scavengers:

3a - Determine bird or mammal species which are expected to be a predator on the cultured species. Guideline distances for separation from concentration areas to avoid disturbance (#2 above) should be used as criteria if the species is a potential

predator. Distance of separation between rearing facilities and predator concentrations can be modified on a site specific basis if other measures will be implemented to minimize predation.

3b - Avoid siting mariculture facilities, including upland support facilities, adjacent to brown and black bear concentration areas.

3c - Avoid siting shellfish farms within areas where diving ducks, particularly scoters and goldeneyes, concentrate seasonally. Rafts or longlines may be sited within 1 mile of concentration areas if they can be sited in waters deeper than the birds traditionally feed on shellfish beds.

3d - Avoid siting shellfish farms within one mile of sea otter concentration areas.

4. To minimize conflicts with and displacement of traditional commercial and noncommercial users of fish and wildlife:

4a - Avoid siting in or adjacent to:

- ° Intensive commercial crab fishing areas
- ° Intensive commercial shrimp fishing areas (pot, trawl)
- ° Intensive commercial clam harvest areas (e.g., geoducks)
- ° Intensive commercial abalone harvest areas
- ° Intensive hunting areas (waterfowl)
- ° Intensive noncommercial fish and wildlife harvest areas
- ° Intensive anchorages within day use areas of major communities for sportfishing and other anchorages of local or regional importance
- ° Intensive float plane access areas
- ° Areas of restricted navigation

["Intensive Use" will have to be determined on a case-by-case basis. Generally, ADF&G conducts an assessment of the importance of a particular harvest area during permit reviews. The public will also have an opportunity to

comment. Due to the variety of uses and lack of data, it is difficult to set specific thresholds. Intensive uses identified here have been identified as ones likely to constitute a conflict in specific situations.]

5. To minimize interference with fisheries enhancement activities:

5a - Avoid siting facilities adjacent to hatcheries or within terminal harvest areas.

6. To avoid adverse impacts relating to water quality:

6a - Applicants should gather site specific information on possible contamination sources, and avoid siting facilities in areas with waste discharges. (e.g., sewage, mine tailings, boat use, etc.)

6b - Applicants should gather site specific information on water characteristics to ensure that adequate water quality can be maintained once culture operations commence. (e.g. salinity, tidal flushing, currents, depths, temperature, etc.)

6c - Applicants should gather site specific information on levels of PSP which may occur naturally in the area, both in native shellfish and bottom sediments.

7. DNR Land use permit/lease guidelines:

7a - Mariculture and competing uses. Mariculture may be allowed on state tidelands where there is no significant conflict and if the proposal is not in conflict with other guidelines. Siting of mariculture facilities may be more difficult on tidelands used for, or designated in area plans for use by, log transfer or storage, mineral transfer or access, and commercial activities. Approvals to locate mariculture facilities adjacent to existing or planned land sales, in crucial fish and wildlife habitat areas, developed recreation areas, and areas used intensively for harvest of fish and wildlife or

for anchorage will also be more difficult to obtain.

Consistent with other guidelines, these areas will be available for mariculture: 1) if land managers determine it is possible to site, design, and operate the two or more uses compatibly in the area, or 2) there is no feasible and prudent alternative for mariculture while one does exist for competing use. In no case will mariculture be allowed to foreclose access to mineral, timber, or recreation resources unless feasible or prudent alternative access exists. However, in some cases it may be in public interest to concentrate uses in one bay rather than allowing proliferation of uses in many bays.

7b - Upland owner support for mariculture. Upland owners are encouraged to identify areas where mariculture (including upland facilities) should and should not be developed and to communicate their conclusions to DNR and to the mariculture industry. Tideland development for mariculture should not conflict with management goals of adjacent uplands as provided by approved plans or policy of the managing agency.

7c - Mariculture caretaker facilities. Floating caretaker facilities for mariculture operations may be allowed. Floating caretaker facilities for mariculture operations will not be allowed in designated recreation or personal use areas unless a determination is made there is no feasible or prudent alternative. Determination will be made available for public comment.

7d - U.S. Coast Guard approval. Permits or leases will not be given until U.S. Coast Guard has certified that proposed facilities will not be a significant navigational hazard.

Project Design Guidelines

8. To minimize adverse impacts on productive benthic habitats:

8a - Increase distance of floating structures from shore to avoid shallow, productive habitats.

8b - In areas where potential for adverse impacts from organic sedimentation is high, minimize density of stocking and increase areal extent.

8c - Use flexible floating structures to minimize dampening action on waves and current flows (i.e., break water effects) to maintain natural circulation patterns.

9. To minimize adverse impacts of disease or toxicants on natural stocks:

9a - Avoid use of creosoted logs and pilings in structures.

9b - Avoid use of anti-fouling chemicals.

10. To minimize adverse impacts on predators or species sensitive to disturbance:

10a - Use nonlethal means of predator control.

10b - Use netting or other materials such as plywood to cover culture structures to provide a physical barrier to potential bird, mammal, and invertebrate predators.

10c - To minimize predation by waterfowl, waterbirds, and birds of prey, aquaculture operations should be covered with plywood or netting that has a mesh size small enough to prevent birds from penetrating it and is made of a gauge heavy enough to be visible to birds and to prevent them from becoming entangled in it. This guideline applies to nets used for both above water and underwater protection.

10d - Plywood or mesh covers on rearing structures should be employed to minimize attraction of bears.

10e - To prevent access by predators, use heavy gauge nets to prevent access.

10f - Operations should be designed and managed to minimize attraction of furbearers. If netting is employed, it should be of a mesh size small enough to prevent entrance and made of a gauge or material that cannot be chewed or clawed apart. Sheet metal collars should be placed on cables, boom sticks, and stiff legs attached to shore to minimize furbearer predation.

11. To minimize adverse impacts on other coastal users:

11a - The culture technique chosen can mitigate impacts on other users of the area if other users are not excluded from access to the area. Bottom culture avoids impacts to many commercial and noncommercial users of fish and wildlife resources, however harvest of bottom dwelling species may be displaced or precluded. Floating facilities are preferable to structures embedded in intertidal area. Longline culture facilities can be designed to be less visible than raft facilities, however low visibility can create navigation hazards. Longlines, by their nature, are more able to withstand rougher sea conditions than standard construction rafts and are suitable in areas of deeper water. Use of longlines provides greater siting flexibility to avoid sensitive areas or use conflicts, and may, in some cases, be a feasible and prudent alternatives to raft culture.

11b - Reduce areal extent of floating facilities to minimum size needed in areas where conflicting uses occur. Consider increasing stocking densities as a means to minimize areal extent.

11c - Provide navigation lanes or access easements through facilities.

11d - Increase distance of floating structures from shore to minimize use conflicts.

11e - Lower floating structures (e.g. nets, longlines) in the water column to avoid conflicts with navigation and recreational use of the area.

Comment: Lowering cultures, either temporarily or permanently within a range of 12 meters below the surface has also been recommended to avoid sets of fouling organisms, high surface water temperatures, rocking of scallops, and unstable salinity and temperature conditions. Growth may be reduced under these conditions, but disastrous events may also be avoided.

11f - Design size, color, and height of structures for low visibility where desirable to minimize impacts to aesthetics and where navigational hazards will not be created. Design high visibility marking devices (e.g., lighted buoys) where necessary for safe navigation.

11g - Consolidate facilities to minimize impacts on other users. However, establish separation distances between farms to minimize cumulative impacts on water quality and potential for disease transmission.

11h - Development plans. A site plan and other relevant information is requested on the Consolidated Shellfish Farm Application. An additional development plan will not usually be required. The preferred approach is for the site plan and other information to constitute a development plan to serve (at a minimum) as basis for DNR, ADF&G, DEC, ACMP, and upland owner review.

12. Upland facility sewage disposal.

12a - A sewage disposal system adequate to protect nearby shellfish from contamination will be required for any caretaker facilities associated with a mariculture operation.

Operational Guidelines

13. To minimize adverse impacts on productive benthic habitats:

13a - Set poles and anchors carefully during periods of lowest productivity.

13b - If structures (e.g., nets) are periodically removed, leave poles and anchors in place.

13c - Monitor sediment build up and impacts on substrate/water chemistry. Adjust stocking rates, remove organic deposits, or move facility if anaerobic substrate conditions are unavoidable.

13d - If herring spawn on structures, leave them in water until the spawn hatches.

14. To minimize adverse impacts on predator populations or species sensitive to disturbance:

14a - Use nonlethal predator control measures.

14b - Use nonlethal means of fouling control.

14c - Garbage should be kept to a minimum and incinerated. Food should be handled to prevent spillage from attracting bears and stored in bear-proof containers. Disposal of garbage by products or dead animals should be done in such a way as to minimize attraction of bears in a site approved by DEC.

14d - Remove structures during periods of conflict with species sensitive to disturbance.

Comment: This measure was identified as a mitigating measure for Nori farms in Washington (Washington DNR 1987). In a programmatic Federal Environmental Impact Statement, they identified the following mitigative measures: 1) removing all rafts when not in use for a period of one month

for production, 2) removing nets not actively used for production, 3) removing nets during herring spawning season if over-spawn of herring outside traditional areas was anticipated, 4) removing nets and structures in less than 10 feet of water depth between March 15 until June 15 every year to prevent impacts on juvenile salmon migration.

15. To minimize the impacts of disease, toxicants, or genetic changes on natural stocks:

15a - In the case of disease outbreaks, notify Alaska Department of Fish and Game and follow existing procedures for control of disease. Use of chemicals and disposal of diseased plants or animals must be approved by DEC.

15b - No exotic species of plants or animals can be imported without approval by Alaska Department of Fish and Game. (by law)

15c - Plants and animals shall not be transported between culture areas or from the wild to a culture situation without approval by Alaska Department of Fish and Game. (by law)

16. To minimize adverse impacts to other users:

16a - Remove structures (e.g., Nori nets) during periods of conflict with other fisheries.

16b - Restrict hours or periods of operation to daytime hours if necessary.

17. Performance standards

DNR will attach reasonable performance standards to permits or leases for project development and operation. Performance standards are to ensure permitted area is used for the approved activity, the proposal is economically viable, and the permit or lease is

not held for speculation or removal of a land base from competition. In all cases approved development plans must be adhered to. If the performance standards are not met, the permit or lease may be revoked.

Sec. 46.40.020. Objectives. The Alaska coastal management program shall be consistent with the following objectives:

(1) the use, management, restoration and enhancement of the overall quality of the coastal environment;

(2) the development of industrial or commercial enterprises which are consistent with the social, cultural, historic, economic and environmental interests of the people of the state;

(3) the orderly, balanced utilization and protection of the resources of the coastal area consistent with sound conservation and sustained yield principles;

(4) the management of coastal land and water uses in such a manner that, generally, those uses which are economically or physically dependent on a coastal location are given higher priority when compared to uses which do not economically or physically require a coastal location;

(5) the protection and management of significant historic, cultural, natural and aesthetic values and natural systems or processes within the coastal area;

(6) the prevention of damage to or degradation of land and water reserved for their natural values as a result of inconsistent land or water usages adjacent to that land;

(7) the recognition of the need for a continuing supply of energy to meet the requirements of the state and the contribution of a share of the state's resources to meet national energy needs; and

(8) the full and fair evaluation of all demands on the land and water in the coastal area. (§ 4 ch 84 SLA 1977)

Stated in *Hammond v. North Slope Borough*, Sup. Ct. Op. No. 2499 (File No. 5550, 5558), 845 P.2d 750 (1982).

Sec. 46.40.030. Development of district coastal management programs. Coastal resource districts shall develop and adopt district coastal management programs in accordance with the provisions of this chapter. The program adopted by a coastal resource district shall be based upon a municipality's existing comprehensive plan or a new comprehensive resource use plan or comprehensive statement of needs, policies, objectives and standards governing the use of resources within the coastal area of the district. The program shall be consistent with the guidelines and standards adopted by the council under AS 46.40.040 and shall include:

(1) a delineation within the district of the boundaries of the coastal area subject to the district coastal management program;

(2) a statement, list, or definition of the land and water uses and activities subject to the district coastal management program;

(3) a statement of policies to be applied to the land and water uses subject to the district coastal management program;

(4) regulations, as appropriate, to be applied to the land and water uses subject to the district coastal management program;

(5) a description of the uses and activities which will be considered proper and the uses and activities which will be considered improper with respect to the land and water within the coastal area;

(6) a summary or statement of the policies which will be applied and the procedures which will be used to determine whether specific proposals for land or water uses or activities shall be allowed; and

(7) a designation of, and the policies which will be applied to the use of, areas within the coastal resource district which merit special attention. (§ 4 ch 84 SLA 1977)

Opinions of attorney general. — The adoption of forest practices regulations by the Department of Natural Resources is 11 AAC 95 has completely precluded the coastal policy council's regulations, 6 AAC 80 100, in regulating timber harvest and processing in the coastal area. April 20, 1981. Op. Atty Gen.

The allocation of responsibility for promulgation of the forest practices regulations in coastal management consistency determinations is sufficiently unclear that it is not appropriate for resolution by the

adoption of regulations since differing policy considerations emphasized in the Forest Practices Act, the Coastal Management Act, and proposed permit reform regulations will be served to a greater or lesser extent by assigning responsibility for interpreting and applying the forest practices regulations to more than one agency and under a particular result is not compelled under the various pieces of authorizing legislation. April 20, 1981. Op. Atty Gen.

ated in Hammond v. North Slope Borough, Sup. Ct. Op. No. 2499 (File No. 85558), 645 P.2d 750 (1982).

Sec. 46.40.040. Duties of the Alaska Coastal Policy Council.

Through the public hearing process and the recording of the minutes of the hearings, the Alaska Coastal Policy Council shall

(1) by regulation, adopt under the provisions of the Administrative Procedure Act (AS 44.62) not later than April 15, 1978, for the use of and application by coastal resource districts and state agencies for carrying out their responsibilities under this chapter; guidelines and standards for

(A) identifying the boundaries of the coastal area subject to the district coastal management program;

(B) determining the land and water uses and activities subject to the district coastal management program;

(C) developing policies applicable to the land and water uses subject to the district coastal management program;

(D) developing regulations applicable to the land and water uses subject to the district coastal management program;

(E) developing policies and procedures to determine whether specific proposals for the land and water uses or activities subject to the district coastal management program shall be allowed;

(F) designating and developing policies for the use of areas of the coast which merit special attention; and

(G) measuring the progress of a coastal resource district in meeting its responsibilities under this chapter;

(2) develop and maintain a program of technical and financial assistance to aid coastal resource districts in the development and implementation of district coastal management programs;

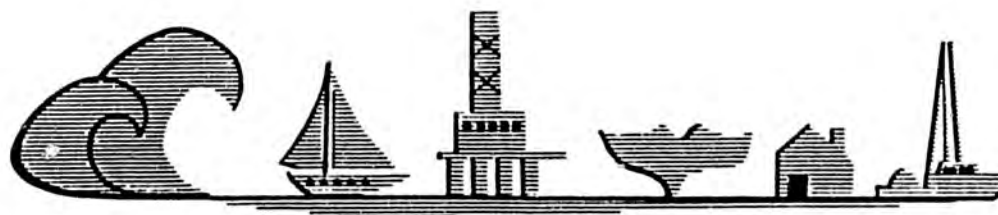
(3) undertake review and approval of district coastal management programs in accordance with this chapter;

(4) initiate a process for identifying and managing uses of state concern within specific areas of the coast;

(5) develop procedures or guidelines for consultation and coordination with federal agencies managing land or conducting activities potentially affecting the coastal area of the state. (§ 4 ch 84 SLA 1977; am § 1 ch 129 SLA 1978)

Alaska Coastal Management Program

1986
Annual Report



State of Alaska
Office of the Governor
Division of Governmental Coordination

Steve Cowper, Governor
January 1987

Introduction

The purpose of this document is to report to the Alaska State Legislature and the public on major actions and activities supported by the *Alaska Coastal Management Program* during 1986.

With the passage of the Alaska Coastal Management Act in 1977, local governments, rural regions, and the State of Alaska began working together to cooperatively manage the use and protection of Alaska's coastal resources. Since 1977, 34 coastal communities and regions have been participating with the state in coastal decisions and preparing plans which specifically address coastal development in their areas. The *Alaska Coastal Management Program* has been an important tool to help the State of Alaska ensure that state interests in coastal development are met, especially in federal actions which affect Alaska's coastal resources and communities.

The *Alaska Coastal Management Program* is designed to:

- bring a broad perspective to decisions on coastal land and water uses
- provide necessary information for use in decision-making
- provide a forum where conflicts can be identified and resolved
- enhance the State of Alaska's role in federal resource decisions and the role of local governments in state and federal decisions, and
- improve the timeliness and coordination of permitting decisions by the state.

Coastal Management: The Legislative Framework

Coastal management planning began with the federal Coastal Zone Management Act of 1972. In the Act, Congress stated its intent to "develop a national program for the management, beneficial use, protection, and development of land and water resources of the nation's coastal zone." The overall goal of the program is a *proper balance of resource development and protection*.

The federal Act encourages states to develop state coastal management programs tailored to their needs and interests. Two incentives are provided. First, the Act authorizes grants to states to develop and implement their programs. Second, the Act requires the federal government, in its discretionary actions, to be consistent with state programs.

The Alaska Coastal Management Act was then passed in 1977 to provide for the orderly and balanced development of Alaska's coast, with full opportunity for the involvement of coastal residents in decisions.



The Alaska Coastal Management Program

The State of Alaska and coastal communities, which are called *coastal districts*, work cooperatively to develop and implement Alaska's coastal management program. Coastal districts include:

- organized boroughs that exercise planning authority
- unified home rule municipalities
- home rule cities, first-class cities, and under certain circumstances, second-class cities
- regional coastal resource service areas directed by elected planning boards.

The Alaska Coastal Policy Council sets policy for the *Alaska Coastal Management Program* and approves coastal district programs. The Coastal Policy Council represents both state and local interests. The Council's membership includes seven state agency representatives and nine locally elected officials appointed by the Governor from nominations submitted by municipalities.

The Governor's Division of Governmental Coordination acts as staff to the Coastal Policy Council, coordinating the development, review, and approval of district programs.

The Coastal Policy Council adopted *standards* for development in the coastal area. The standards are general policies guiding various kinds of coastal development. These standards form the state program in areas where district programs have not been developed and approved by the Coastal Policy Council. Moreover, coastal districts must consider the state coastal management standards in the development of their district programs.

Standards have been adopted for the following topics:

- coastal development
- geophysical hazard areas
- recreation
- energy facilities
- transportation and utilities
- fish and seafood processing
- timber harvest and processing
- mining and mineral processing
- subsistence
- habitats
- air, land, and water quality
- historic, prehistoric, and archaeological resources

District Planning

Districts develop coastal management programs that include a resource inventory, a statement of the district's boundaries, policies for coastal development, and methods for implementing the program. The districts follow a *public participation and review* process specified in state guidelines. This process includes the development of two documents that are widely distributed for public review: the public hearing draft and the conceptually approved draft.

Some coastal areas have unique or significant values or uses associated with them. The Coastal Policy Council has the authority to adopt special management plans for these areas which merit *special attention*, which may be located either inside or outside of coastal districts.

After extensive public review and Coastal Policy Council approval, coastal district programs are submitted for the approval of the federal Department of Commerce, National Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resource Management (OCRM). These submittals are processed either as routine program implementation actions or as amendments to the *Alaska Coastal Management Program*. A determination by OCRM that a district program is an amendment initiates an extensive additional review by OCRM.

Once state, local, and federal approvals are granted, the programs are used to guide land and water uses and activities that have a direct and significant impact on coastal waters.

Program Implementation

Until district coastal management programs are developed and approved, state resource agencies use individual agency authorities to implement the *Alaska Coastal Management Program* standards in coastal areas of the state. Once district programs are fully approved, planning and management actions of state agencies must be consistent with the standards and with applicable district programs; the actions of districts must also be consistent with their coastal management programs.

Under the *Alaska Coastal Management Program* and the state consistency review process regulations (6 ACC 50), the Division of Governmental Coordination (DGC) schedules and coordinates agency review of all required state permits for projects located in Alaska's coastal area. DGC seeks to achieve agency consensus on project approvals. Once a proposed coastal development project has been found consistent with applicable standards of the *Alaska Coastal Management Program* and specific agency permit requirements, project permits are issued. The majority of projects reviewed for consistency are approved in review timeframes of either 30 or 50 days. DGC maintains regional offices in Anchorage, Fairbanks, and Juneau for convenient access by development project applicants. Having regional offices also facilitates timely project reviews and permit issuance by state resource agency personnel having the greatest familiarity with the natural resources of each region. The result of this process is that the time and effort needed to obtain state approval for a variety of permits is significantly limited, especially for projects requiring several federal and state approvals.

The consistency review process for coastal projects serves to:

- streamline and expedite reviews and decisions on coastal development projects
- establish uniformity in the state's comments and decisions on proposed projects, including direct federal actions or federally permitted development projects
- eliminate repetitive review decisions
- provide opportunity for public and local participation in state decisions
- assist applicants in the processing of state and federal permits
- achieve balanced, factually documented decisions including consideration of the costs and benefits of requiring a particular stipulation
- provide a mechanism for resolving conflicts between agencies, the applicant, and the local community, and
- render a conclusive consistency determination for coastal projects that must be reviewed for consistency with the *Alaska Coastal Management Program*.

1986 Progress Report

A summary of *Alaska Coastal Management Program* and district achievements in 1986 follows. More detailed information on the current

status of individual coastal district programs and district activities in 1986 is provided in the next section of this report.

Coastal Policy Council Actions

In 1986, the Coastal Policy Council approved three coastal district programs, three amendments to programs, and two plans for areas which merit special attention. The Coastal Policy Council approved the *City and Borough of Juneau* coastal management program, the *Northwest Arctic coastal resource service area* coastal management program, the *City of Valdez* coastal management program, and an amendment to the *City of Cordova* coastal management program. To

address federal concerns with the *Aleutians East* and *Bristol Bay* coastal resource service area programs, which were approved by the state in 1985, the Coastal Policy Council approved amendments to these two programs. The Coastal Policy Council also approved plans for two areas which merit special attention: the *Juneau downtown waterfront* and the *Eyak Lake* area adjacent to the *Cordova* coastal district.

8. Oregon Coastal Management Program Summary

Program Summary

The Oregon Coastal Management Program (OCMP) is part of Oregon's statewide program for coordinated land use planning. The program is a partnership between local governments and state and federal agencies to resolve general and often competing interests through land use plans and implementing measures for all lands in Oregon's coastal zone. The program is based primarily on the Oregon Land Use Planning Act (ORS 197) and its requirements including the statewide planning goals and requirements for state-approved comprehensive plans. The program also includes specific resource management authorities in other state laws.

The statewide planning goals are regulations adopted by the Land Conservation and Development Commission (LCDC) which set minimum standards for comprehensive planning and other government decisions affecting land use. The goals also express the state, regional, and national interests in land use. Four of the goals set specific standards for planning of coastal resources including estuaries, shorelands, beaches and dunes, and the ocean.

Comprehensive plans developed and administered by coastal cities and counties are the primary vehicle for implementing the goals. Plans must be fully coordinated with the needs and policies of state and federal agencies, special districts, and the public. Once approved by LCDC, a plan serves as the state's standards for all land use decisions within the geographic area it covers.

Several state laws for management of coastal resources are also included in the Oregon Coastal Management Program. These include the Removal-Fill Law, which regulates alterations to estuaries, lakes and other waterways, and the Oregon Beach Bill which regulates uses and alterations along the ocean shore.

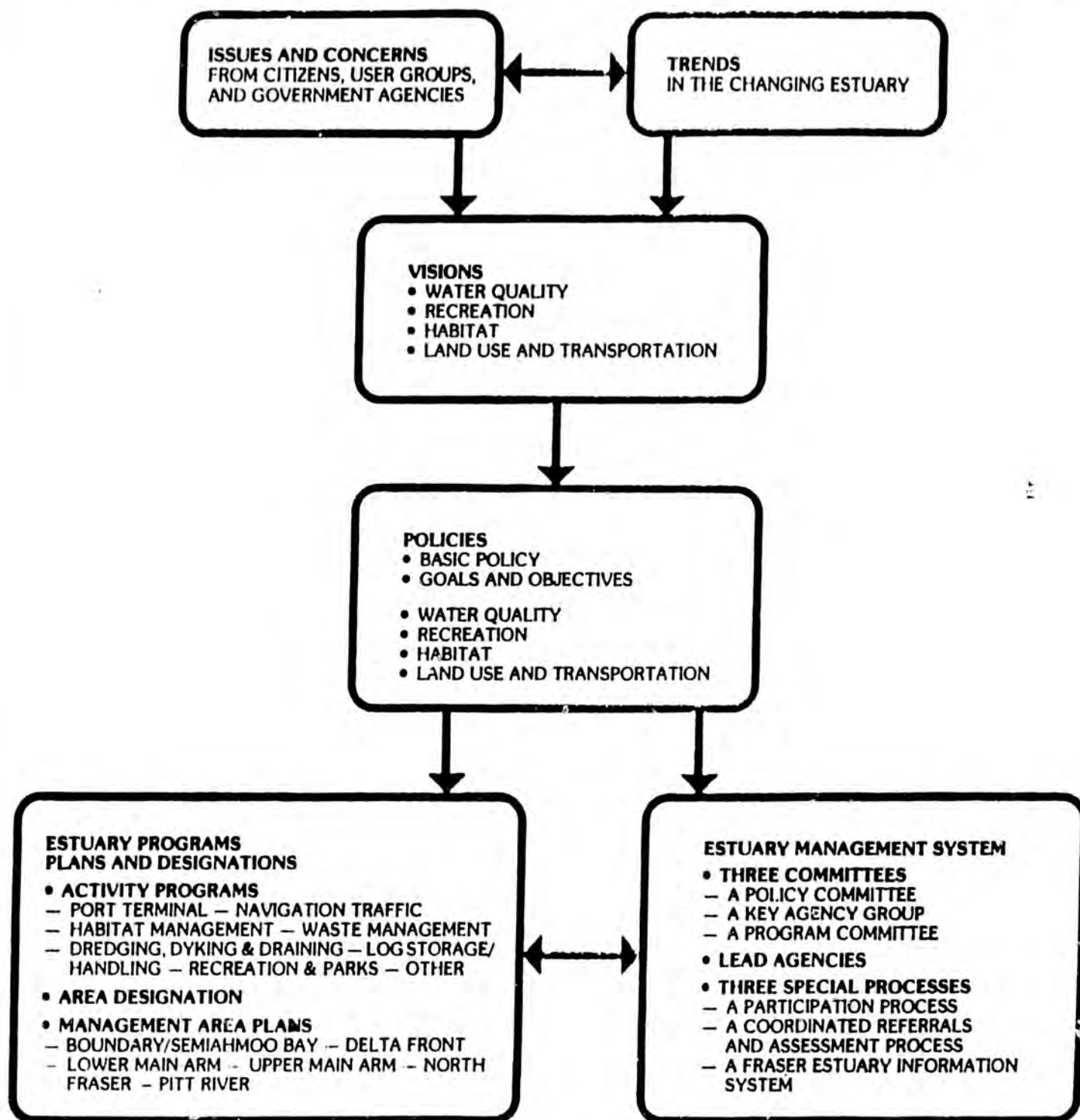
Together, the goals, comprehensive plans, and state statutes express particular concern about the importance of protecting estuarine, agriculture and timber resources; about the needs for water-dependent development, port development, energy production and commercial fishing; about flooding and erosion hazards associated with development in shoreland and beach and dune areas; and about recreational access, urbanization and the maintenance of open space. Through the goals, coordinated comprehensive plans and provisions of other state statutes, Oregon has a program which addresses these issues.

The objective of the OCMP is to develop, implement, and continuously improve a management program which will, as appropriate, preserve, conserve, develop and restore the natural resources of the coastal zone. The program attempts to create and maintain a balance between conservation and development, and between conflicting private and public interests. This balance is intended to assure the greatest benefits to this and succeeding generations of Oregonians.

Oregon's participation in the federal coastal zone management program has resulted in increased technical, financial and legal assistance to local governments, regional agencies and state agencies in managing coastal resources. The state has received funds to foster the development and implementation of coordinated comprehensive plans, to acquire the South Slough Estuarine Sanctuary, to create a technical data base for use in making more informed decisions, and to identify and plan for the impacts of coastal energy development. The state expects that future funds will be available for these purposes as well as for ongoing research, public education and for beach access. Finally, because Oregonians have taken the lead in wisely and responsibly managing their coastal resources, participation in the federal program assures that, under federal law, actions of federal agencies which affect the coastal zone will be consistent to the maximum possible extent with Oregon's program.

9. Fraser River Estuary Management Program - flowchart (from
"A Living River By the Door")

FRASER RIVER ESTUARY MANAGEMENT PROGRAM



10. Aquaculture Industry Overview: Statistics

AQUACULTURE IN BRITISH COLUMBIA

FIGURE 1- FARM SITES (OPERATION AND INVESTIGATION)
MAY, 1988

NORTH COAST

	Operate Farm		Investigate Site	
	Approved	Applied	Approved	Applied
Finfish	4	11	6	29
Shellfish	2	0	0	0

MID-COAST

	Operate Farm		Investigate Site	
	Approved	Applied	Approved	Applied
Finfish	0	2	0	3
Shellfish	0	1	0	0

VANCOUVER ISLAND

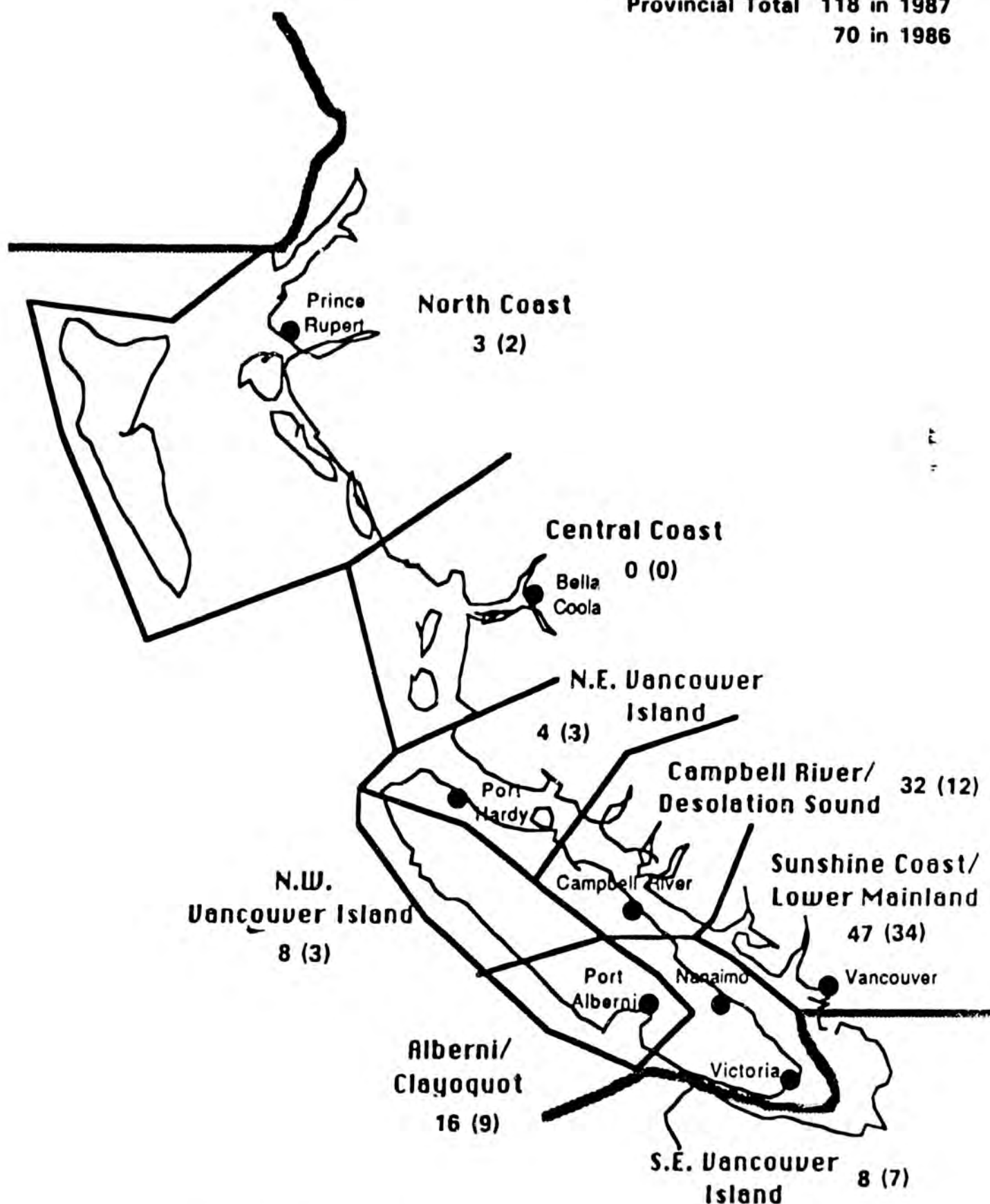
	Operate Farm		Investigate Site	
	Approved	Applied	Approved	Applied
Finfish	98	101	133	24
Shellfish	296	83	0	1

LOWER MAINLAND

	Operate Farm		Investigate Site	
	Approved	Applied	Approved	Applied
Finfish	76	33	18	18
Shellfish	106	32	3	2

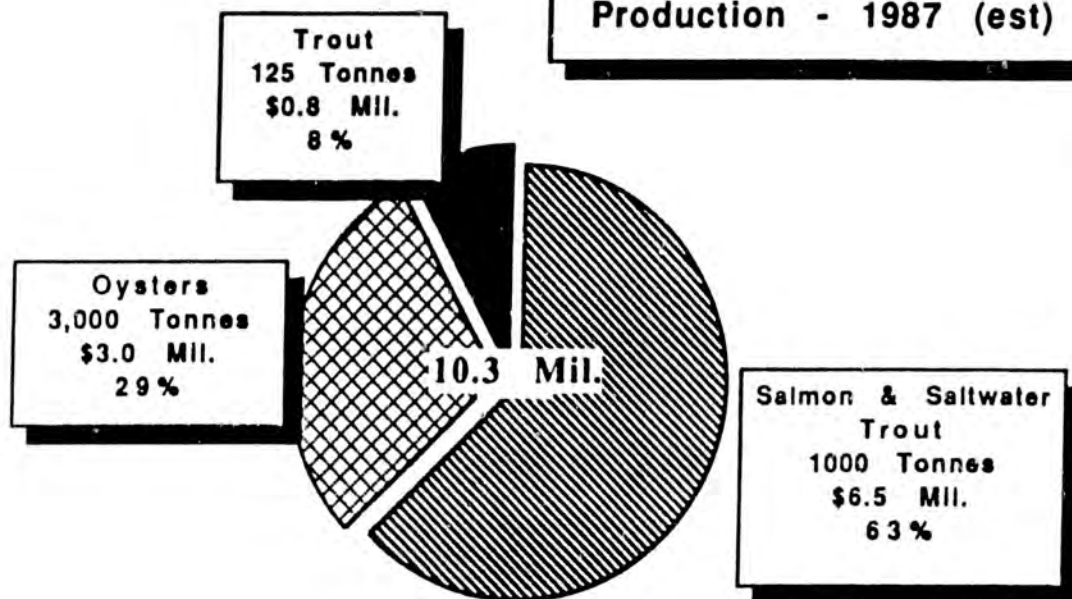
DISTRIBUTION OF OPERATING FARMS IN BRITISH COLUMBIA

Provincial Total 118 in 1987
70 in 1986

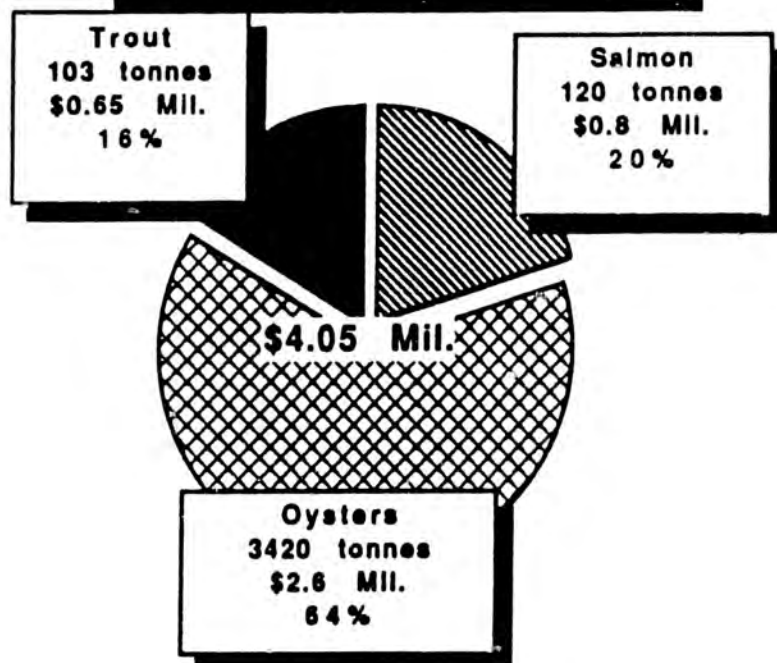


Up to November 30, 1987. Numbers in parentheses were the farms operating up to October 30, 1986.

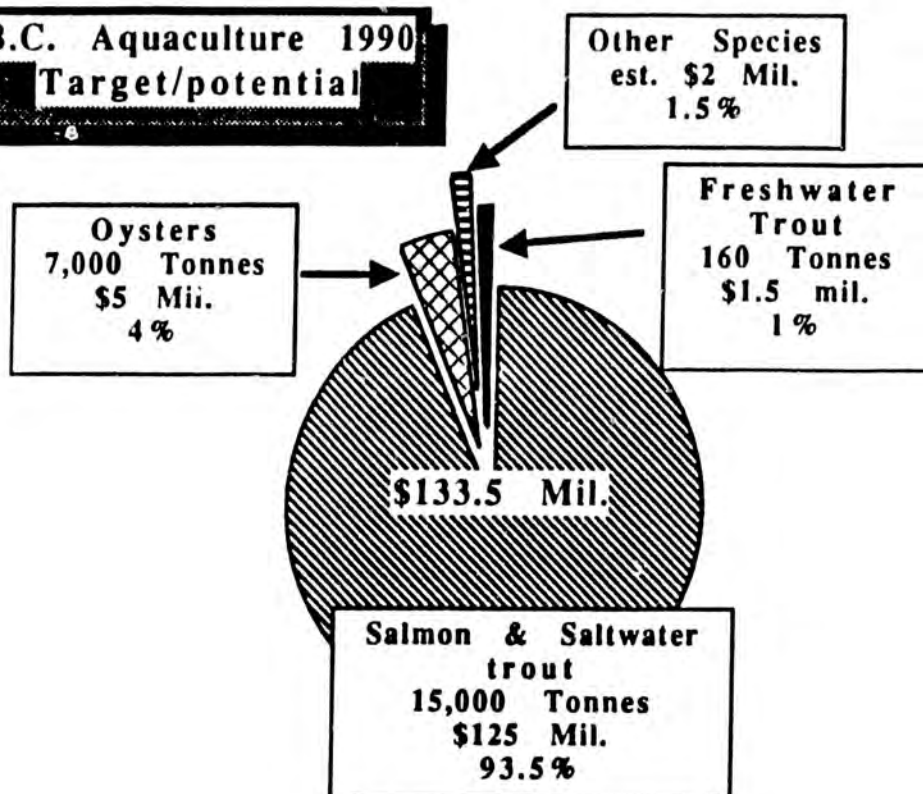
**B.C. Aquaculture
Production - 1987 (est)**



**B.C. Aquaculture Production -
1985**



**B.C. Aquaculture 1990
Target/potential**



11. Excerpt from Summary of Recommendations of Coastal Zone
Resource Sub-Committee (May 1977)

Summary of Coastal Zone Resource Sub-Committee
Recommendations:

1. Early consideration should be given to the establishment of an ongoing inter-governmental mechanism, comprised of the appropriate governmental agencies, whose fulltime commitment would be to:
 - A) Provide coordinative and advisory function to coastal related programs and plans or requests of government and non-governmental organizations, including the dissemination of information to the general public;
 - B) Identify regional resource management strategies and options and develop operating guidelines for integrated coastal resource management and protection;
 - C) Assess current initiatives, such as the joint federal/provincial study program on the Fraser River and Estuary, with regard to their applicability to other regions of the coast;
 - D) Direct the development and implementation of an integrated coastal resource management program by coordinating the following tasks:
 - i) The preparation of a coastal resource folio or atlas which provides an overall perspective of the coastal zone, including its physiographic, biotic, oceanographic and climatic regions, and boundaries, as well as associated coastal processes and natural resource values and uses. The scale of this folio should be at the "broad resource allocation level".
 - ii) The development and implementation of a "biophysical" inventory program for the coastal zone. Particularly for use with the shoreline and marine components of the coastal zone, this program will require:
 - a) The development, testing, and application of inventory methodologies and classification systems;

- b) The coordination of current and presently scheduled research and inventory efforts which may be pertinent to the program;
 - c) The establishment of research programs oriented towards in-depth examination of selected factors within biophysical resource systems;
 - d) The development of stronger liaisons between information generating and informed using agencies to ensure that the information is of a format and scale facilitating its immediate and maximum use;
 - e) The identification of appropriate criteria (classification systems) for such interpretations as use capability, use suitability, impact sensitivity, and potential harvestability.
- iii) The analysis of specific problems recurring in the coastal zone and the identification of priority geographic and subject areas requiring detailed inventory, research and management efforts.
- iv) The review of existing referral systems with a view towards identifying specific changes that can and should be made. Aspects that require further investigation include:
- a) The simplification of some referral systems and the expansion of others to include the interests of additional agencies;
 - b) The improvement of some referral systems with respect to quality and quantity of information circulated so that recipients can make informed judgments;
 - c) The addition of increased resources and analytical capabilities of some of the participants in referral systems, in order that these agencies can give adequate consideration to referrals.

- v) The identification, in cooperation with the above activities, of the role and orientation that research should take in the coastal zone. Areas requiring further collaborative investigation include:
- a) The design of a system to identify the biological and physical variables that should be routinely monitored in specified coastal resource systems;
 - b) The identification of specific proposed or ongoing developments suitable for monitoring experiments applicable to future impact prediction;
 - c) The assessment of the application of advanced technology to coastal zone management (e.g. the Landsat satellite for reconnaissance inventories and for monitoring of B.C. coastal environment);
 - d) The assessment of existing governmental and university data banks (in cooperation with agencies and experts in this field) with the view to assessing integrated data sets and options for developing an integrated, computerized data management system (storage, retrieval and analysis) for the coastal zone;
 - e) The assessment of existing and future fundamental research needs with respect to biological and physical processes, system interrelations, etc..
- vi) The development of programs for public information, and the education of governmental personnel in the field of coastal zone management. Number of options could be pursued;
- a) Educational programs (lectures, courses, multimedia presentations and field demonstrations, etc.) emphasizing: - the significance of the coastal zone, its resources and its problems; - the necessity of establishing a biophysical basis for coastal resource management decisions. (For example, current efforts to communicate

these concepts to coastal regional districts, key coastal municipalities, key provincial agencies, coastal oriented private industry and public interest groups should be expanded).

- b) Encouraging interdisciplinary programs for resource management. Scholarships for graduate students interested in coastal resources should be offered and provision should be made for study leaves for government employees to take courses and degree programs in this field.
- c) Procedures for expediting the communication of research results and management experience elsewhere should be enhanced. These should be implemented in addition to training programs, and would involve provisions for reporting on contract research, for mounting and attending conferences, and for visiting other agencies of government.

vii) Consistent with the various management decisions to be made, existing socio-economic data should be collected, analyzed, and specific data needs should be identified. Future study programs should include the development of methodologies for generating socio-economic information and for integrating it with biophysical data.

- 2. The initial focus for the above initiatives should be in the Strait of Georgia region, and more specifically should concentrate on the southeast coast of Vancouver Island, the Lower Mainland and Howe Sound.
- 3. Existing biophysical data and socio-economic data (as it is generated) should be made available to local jurisdictions in a readily usable form, (e.g. guidelines for the use of biophysical data in decisions regarding land and resource use management should be developed). In addition, such methods as the provision of technical expertise to assist coastal municipalities and regional districts with the zoning and development control processes should be considered. Similarly, general policy and management guidelines for the coastal zone should also be developed and distributed to development oriented agencies (government and private) to guide them

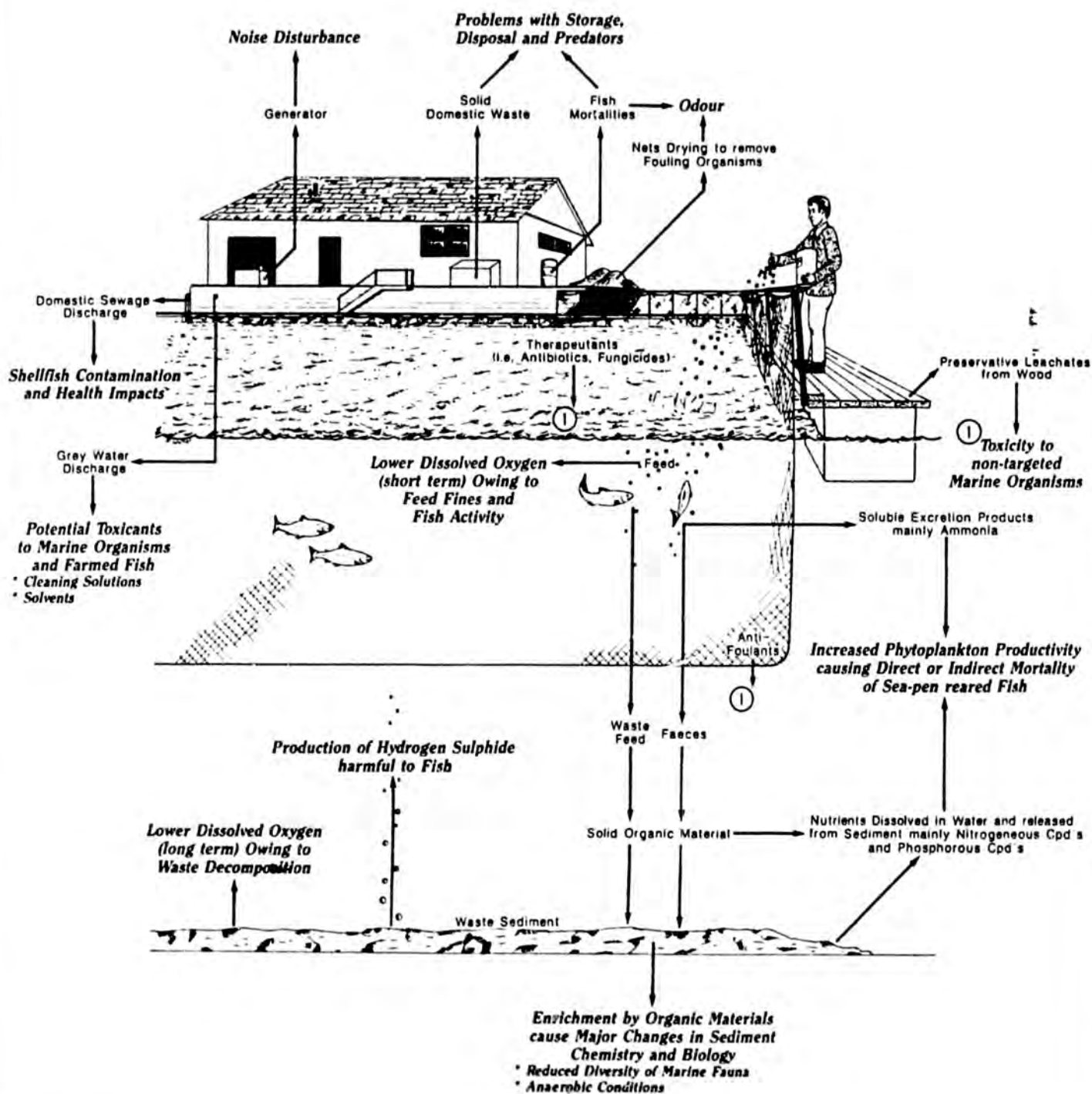
in planning the location and scale of proposed facilities. For example, consideration should be given to the desirability of developing an impact assessment policy for the coastal zone along the lines of the recent provincial order-in-council made in respect of Sturgeon and Roberts Banks and Boundary and Semiahmoo Bay.

4. Coastal resource management plans which designate the uses of land and water resources should be developed. Since the formulation and implementation of such plans would be greatly facilitated by the provision of background information - biophysical, social, economic - in a form which allows resource use options including their benefits and costs to be easily identified and assessed, there is an obvious need to establish a close-working relationship between this management function and the function of information generation and dissemination as identified in Recommendation No. 1 above.
5. Ongoing financial and administrative mechanisms at both the federal and provincial levels should be considered to facilitate the acquisition of lands and features which merit conservation but are not protectable through existing mechanisms.
6. The public should have the opportunity to participate in coastal resource use decisions. Approaches suggested for ensuring the representation of an informed public and decision-making include:
 - A) The establishment of a central and/or regional information centre(s) on coastal resource management;
 - B) The provision that those agencies or government which reflect the range of public interests have an opportunity to participate in the decision-making process;
 - C) The provision of an opportunity for affected interests to participate directly in the decision-making process;
 - D) The provision of funding to public interest groups in order that they may develop position papers and education programs.
7. There are a number of initiatives that can and should be pursued on an individual agency basis. Those identified to date include: the incorporation of ecological criteria into the resolution of problems associated with accreted

lands, particularly with respect to acquired private property rights and land use; and the controlling of unauthorized long-term use of Crown lands (trespass).

12. Possible impacts of a salmon farm upon the marine environment (courtesy Ministry of Environment and Parks)

POSSIBLE IMPACTS OF A SALMON FARM UPON THE MARINE ENVIRONMENT



13. Commentary on Washington State Timber, Fish, Wildlife Agreement.

Appendix 13

Commentary on Washington State Timber, Fish, Wildlife Agreement

The origin of the TFW agreement can be traced to a recent U.S. federal court decision upholding certain Indian treaty rights which caused the forest industry to be concerned to the point that it looked for creative options in order to alleviate the risk of a potential loss in higher courts. The result, through application of principles of consensual dispute resolution, was an agreement hammered out through hundreds of hours of meetings among representatives who were committed to achieving their own positive objectives, rather than attaining absolute victory over those interests they perceived to be adverse to their own. The process recognized the inherent limitations of legislation in the control of human conduct. While this office is of the opinion, and recommends, that public management systems have their bases in legislation, wise management of the physical environment must recognize the human component as critical to achieving the legislative objectives. The TFW process did just that.

The process began with informal discussions that included all known interest groups and agencies. Out of those discussions, "which eventually involved all the appropriate State agency people, industry, environmental folks and tribal representatives," came an agreement for an exploratory meeting.

The purpose of the exploratory meeting lasting two and half days was to define positive goals for each group: "We agreed that anybody who stayed in the process after the two and a half days, had to be committed to achieving all of the goals. If you couldn't subscribe to that, you took yourself out of the process. And if you stayed, agreeing to abide by the goals, decisions would be made by consensus, not by vote."

Thus was achieved a fundamental shift in the orientation of public resource regulation - rather than a series of commands from courts or government agencies, the participative process

by which regulatory goals were defined gave each group a personal stake in the success of the program. Jim Waldo, a Seattle attorney who was one of the key architects of the TFW agreement, has described it as follows:

"It took six arduous months to complete the building of the TFW process. The entire premise of forest management in the state of Washington was changed from a regulation based system (in other words if it's in the regulation you're going to have to do it, but if it's not in the regulations you don't have to do it). From this we went to a system that is based on managing towards certain goals and far more sensitive to site-specific situations, location by location. Regulations are still there, but only as a stop-gap where the parties find it impossible to find any other way to conduct their business."

"We also set up a priority matrix where we have concerns about how an operation is conducted. And instead of trying to deal with it by regulation, we identified where those conditions are likely to occur and through a series of fundings at the state level and agreements between industry, environmental groups, the tribes, and state agencies, we have interdisciplinary teams that go out and have a look at those proposed timber cuts. And they don't start with a set of regulations. They start with a set of concerns, or issues about those cuts, and they tailor how that cut is going to occur. We've been at this process informally for about five months now, with eight or nine of these interdisciplinary teams in the field."

The ultimate goal of the TFW process was to create a management environment in which cooperative relationships based on mutual respect and understanding supercede the former system based on fractious, adversarial postures and continual attempts to crush opponents' interests through legislation and litigation. As Jim Waldo expressed it: "Ultimately, it means developing a system where relationships improve over time so that pretty soon the way you solve problems is to pick up the telephone."

It should be remembered that legislation did have its part in the TFW process. The ultimate agreement forged out among all of the groups involved, and specifying a process involving scientific, managerial, and policy input, with a research and monitoring component, and the previously

mentioned "inter-disciplinary teams", passed into legislation through the State Legislature and Senate with no opposing votes.

It should again be stated that American experience with negotiated dispute resolution, as with coastal management, has not been utopian. Differences in governance systems between the U.S. and Canada must be considered in any attempt to "institutionalize" consensual dispute resolution mechanisms. As with coastal management, this report attempts to isolate the principles of fairness within specific contexts. Dorcey and Riek in a paper entitled "Negotiation-based Approaches to the Settlement of Environmental Disputes in Canada" have observed a number of differences between Canadian and American governance systems which are worth reviewing:

- Property rights and due process [apart from criminal matters] are not enshrined in the constitution in Canada.
- The constitutional division of responsibilities for natural resources gives the provinces a much bigger role than states in the Canadian federal system.
- Federal and provincial government executives (i.e. Cabinets) in Canada have much greater freedom to act; they are not so constrained by the courts and legislatures as in the U.S.
- The discretionary nature of Canadian legislation and the weak development of administrative compliance legislation have resulted in much less use of the courts in Canada.
- The courts in the U.S. have historically taken a more interventionist role and this is only slowly evolving in Canada under the influence of the new Charter of Rights and Freedoms.
- There is a greater tradition of self-governance and litigation that grew out of the revolution in the U.S., in contrast to the tradition in Canada that the government has always been there and the Crown can do no wrong nor be sued.

Dorcey and Riek take note of two phenomena peculiar to the different legislative environments in Canada and the U.S.: firstly, in Canada there is much less use of bargaining and negotiation "that is stimulated by a desire to avoid the courts". (This can be seen to have been the major impetus toward success in the Timber, Fish, Wildlife Agreement; unfortunately it was a stumbling block to a similar agreement to enable aquaculture development to proceed in Washington State - the court system was perfectly acceptable for some parties who believed they would prevail in a legal contest.) At the same time, Dorcey and Riek note that smaller Canadian bureaucracies, operating under "highly discretionary legislation" with relatively weak powers of administrative compliance, have likely increased the feasibility of useful, productive bargaining and negotiation.

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