

ALASKA LEGISLATURE SPECIAL COMMITTEE/SUBJECT FILE 8672
1863 SCOMM 75: MARICULTURE (FISH FARMING), 1987-1990

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applicant should also be required to notify local residents and local government of his intentions, as a means of activating discussion. Such notification will be of value to the applicant in site and facility planning as well as in determining the likelihood of local government cooperation.

- 4.7.5 The provincial lands agency should place greater emphasis on local government input to the finfish aquaculture referral process.

The degree to which local government referral comments influence provincial decisions on aquaculture should be clearly identified in government policy. The relevance of local government comments has generally been minimized by the lack of time available to respond to the referrals. Extension of the referral period to 60 days should assist in lending more weight by providing local government the opportunity to obtain additional information. Local governments should use the additional time to refer the applications to local advisory committees or to affected adjacent landowners for input, as a means of increasing the impact of their recommendations.

4.8 PRODUCTION PLANS AND DILIGENT USE

- 4.8.1 The provincial government should remove requirements for cost, husbandry, production and harvest strategies from its fish farm production plan.

The Inquiry believes the involvement of government in finfish aquaculture is more appropriately directed to the protection and proper management of public resources, rather than to private businesses and privately-owned fish. Removal of costing information, husbandry strategies, production and harvest strategies from existing production plans is needed to return the government focus to resource management, and to assist in streamlining the approval process. Increased government field extension services, and the need to obtain business financing should ensure that the prospective aquaculturist is cognizant of these requirements. Site characteristics, locational information, and

schedules of improvements should constitute the main elements of the plan for site management.

- 4.8.2 The provincial government should establish minimum fish production levels and environmental quality standards for use in measuring diligent use, and increase its site monitoring and inspection activities.

Standards are required to allow government to determine whether or not a finfish aquaculture operation is making appropriate use of a tenured site. A minimum production level of fish is the simplest and most appropriate measure of diligent use from a development perspective. Standards should be prepared on the basis of current knowledge of fish mortality and growth rates by species at different ages, and combined with an applicant's schedule of net pen improvements to establish annual production levels for each year of operation on a site. From a protection perspective, diligent use should be measured according to changes in site environment as measured against standards proposed as per Recommendation 4.5.2. Failure to maintain environmental standards or to achieve fish production levels should be a basis for tenure cancellation. The existing level of site inspection must also be increased to enforce diligent use.

- 4.8.3 Production plans for site and improvement locations should be expanded to include the demarcation of public use and access requirements.

The production plan approved by government becomes a legally enforceable component of the lease or licence tenure. It therefore provides an opportunity to legally incorporate desirable forms of access and assistance to other users. The site map and location of improvement submitted in a plan should be required to indicate provisions for emergency or overnight anchorage, access channels to public beach, and riparian access channels for upland owners where applicable. These requirements are appropriate to promote cooperation between private finfish aquaculture and public interests along the coastline.

- 4.8.4 The production plan process should establish a priority system to accommodate review and approval of significant plan revisions necessitated by disease outbreak, tenure assignments, and other factors influencing tenured operations.

The policy of requiring approval of alterations to existing production plans is basically sound but causes difficulty as a result of the existing backlog of production plans in the review process. Government should give priority to review of modifications required for existing farms. This practice should not be used to expedite the plans of farms which are in illegal occupation of sites, but rather to accommodate problems or requirements of existing tenured farms.

4.9 LAND TENURE

- 4.9.1 The provincial government should continue its use of Section 10 of the Land Act to authorize site investigations for finfish aquaculture.

The Section 10 licence is an appropriate form of tenure for the finfish aquaculture industry. It provides the opportunity to conduct site research and investigation without committing government to subsequent approval of a fish farm. Unfortunately its use has been largely responsible for the "gold rush" image created in the public mind and has been abused in some areas by establishment of unauthorized improvements and fish production. To offset this negative image and more accurately reflect its nature, the Section 10 should be renamed (eg. "investigative permit"). In addition, government should begin to increase its surveillance of these permits and cancel them upon discovery of abuse.

- 4.9.2 The provincial government should require a commitment bond to accompany all finfish aquaculture applications.

A commitment bond is recommended as a means of minimizing the ability of applicants to tie up potential sites for speculative or competition reducing purposes. As the name implies, this bond should establish the

commitment of an applicant to seriously pursue his aquaculture interests. The Inquiry believes that such a bond should also be used to provide a source of funding for joint government-industry research on aquaculture development and environmental effects. Consequently the bond should be levied for all types of finfish tenure applications. Government should implement a system of refunds and partial refunds for the bond, which ensures that each application generates some level of support for research on the basis of success in the approval process. With this bond system in place, it may be unnecessary for government to retain an arbitrary ceiling on the number of sites which can be applied for by one applicant.

4.9.3 The provincial government should revise its rental rates and clean-up bond requirements for finfish aquaculture tenures.

Inadequate rentals and clean-up bonds are a recognized weakness in existing government policy. The maximum rental of \$200 per year is insufficient compensation to government for private use of Crown land. The Inquiry recommends a new rental structure be established, consistent with other approaches used by the provincial government. Clean-up bonding should also be required as a condition of tenure. Government should require deposit of a bond to cover clean up expenses in the event of cancellation or abandonment of the site tenure. The bond should be accessible to provincial and federal agencies responsible for rehabilitation of such sites.

4.9.4 The provincial government should review and expand its legal tenure documents for finfish aquaculture.

This report recommends a shift in the regulation process towards provision of environmental safeguards, consideration of other user interests, and conflict avoidance. Such items should be incorporated as legally enforceable provisions of leases and licences issued for finfish aquaculture operations. They include special provisions for mandatory site monitoring and reporting, aesthetic and visual standards, and demarcation of tenure area. The identification of naviga-

tion and access channels and emergency anchorage should also be included as per Recommendation 4.8.3.

4.10 PROVINCIAL AGENCY APPROVAL SYSTEM

4.10.1 The present provincial agency approval framework should be maintained.

The Inquiry believes that the finfish aquaculture approval system should continue to evolve within the existing framework of legislative responsibilities. Establishment of a "single window" agency 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 (eg. an Aquaculture Act) would create anomalies and inconsistencies among remaining programs of the affected agencies. The Inquiry suggests that agencies involved in the existing process should continue to work together using operational agreements and other mechanisms to achieve their objectives. Policies and procedures should be constantly reappraised to ensure they continue to encourage orderly development of the industry and safeguard the public interest.

4.10.2 The role of the Ministry of Agriculture and Fisheries as lead provincial agency should be clarified and focussed.

The role of lead agency is presently blurred by the heavy involvement of the Ministry of Agriculture and Fisheries in production plan approvals. As such it is often perceived as a support agency for the Ministry of Forests and Lands, which is responsible for approval of land tenure. Absence of a major field extension and information services program also diminishes the public perception of Agriculture and Fisheries as the lead aquaculture agency. To clarify its role, the Ministry should reallocate its aquaculture resources to satisfy ever-increasing needs for extension services to fish farmers, information to the public, and research support to both industry and environ-

mental monitoring agencies as per recommendations in Section 4.2. In addition it should begin a central inventory service for up-to-date information on tenures, land interests, land conflicts, and coastal resource inventory data of value to future aquaculture planning and development.

4.11 REPORT IMPLEMENTATION

- 4.11.1 Due to the broad scope of the Inquiry terms of reference, the report on finfish aquaculture in B.C. should be reviewed by all provincial government ministries with responsibilities for implementation of its recommendations.
- 4.11.2 The implementation of recommendations by individual agencies should be done in a coordinated manner and over as short a time period as possible to minimize disruption to the finfish aquaculture industry and to prevent speculative activity.
- 4.11.3 Adjustments to the government approval process and the preparation of coastal resource identification studies should be performed over the same time frame.
- 4.11.4 In fairness to those tenures caught in the government moratorium, finfish site applications filed before October 31, 1986 should be allowed to proceed under existing policies and procedures. Those received after the October 31 moratorium should be subject to new policies, procedures, and resource study restrictions as they fall into place.
- 4.11.5 Given the many similarities and the efficiency of a single policy framework, the recommendations of the Inquiry on finfish aquaculture should be considered by government for their application and relevance to other forms of commercial aquaculture.

SALMON FARMING IN BRITISH COLUMBIA

Prepared by the B.C. Salmon Farmers Association

WHAT IS THE B.C. SALMON FARMERS ASSOCIATION?

The B.C. Salmon Farmers Association 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.

Starting with nine charter members, the Association's membership now totals 75, which represents some 95% of active salmon farmers in British Columbia. A ten member Board of Directors, representing a cross-section of members with respect to size of operation and geographic location, establishes policy. A full-time staff of six implements policy and administers the affairs of the Association.

To broaden the range of services delivered to members, the Association has recruited a Director of Communications, a Director of Research and a Director of Marketing. Comprehensive programs will be developed in each of those areas and implemented early in 1987.

The Association has initiated and now operates active programs in the following areas:

- disease screening
- egg allocation
- brood stock development
- marketing studies
- education

Disease Screening

A program to halt the vertical transmission of disease from parent salmon to offspring was initiated by the Association in 1985. Screening techniques and protocols were developed in conjunction with Malaspina College, Nanaimo, and with the staff of the Pacific Biological Research Station, Department of Fisheries and Oceans, Nanaimo. The program ensures that all diseased eggs are destroyed and only disease-free eggs are distributed to salmon farmers.

Disease screening is not utilized on eggs used in the Department of Fisheries and Oceans' Salmonid Enhancement Program (SEP), thus increasing the risk of disease being introduced into the wild salmon stock.

Program costs of \$250,000 in 1985 and \$600,000 in 1986 were paid by farmer members of the Association. In addition, salmon farmers paid for some \$100,000 worth of laboratory and other equipment required by Malaspina College to conduct the disease screening program.

In 1986, the Ministry of Agriculture and Fisheries provided \$60,000 to fund development of a comparative method analysis for disease screening. This method is expected to increase screening effectiveness at reduced cost in future years.

CORRECTION

**THIS DOCUMENT
HAS BEEN REPHOTOGRAPHED
TO ASSURE LEGIBILITY**

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Egg Allocation

One of the Association's principal functions is to allocate eggs to farmer members, a role the Association accepted in 1985 at the request of the Department of Fisheries and Oceans. Up until that time, a salmon farmer ordered eggs direct from the Department. But as the number of farms increased, the Department found it increasingly difficult to satisfy demand on an equitable basis, and asked the Association to develop and administer an equitable egg allocation system.

The Association's present allocation system is based on three main principles:

1. New farms are assured enough eggs to start their own brood stock.
2. Existing farms expanding their capacity have the same egg rights as new farms, to the extent of the expansion.
3. Farms with product in the water get first right to egg quantities equivalent to those received in the past, provided that total industry needs are considered.

Historically, all eggs have been purchased from the Department of Fisheries and Oceans hatcheries. These eggs are from fish returning to Salmon Enhancement Program hatcheries and are surplus to S.E.P. management needs. Any of these returning fish not used by B.C. Salmon Farmers Association members for eggs are sold to processors; thus, any eggs not used by the industry are wasted.

As domestic brood stocks develop, reliance on S.E.P. sources will decrease over time. The point at which the industry achieves self sufficiency in egg supply will depend on its rate of growth, but the advantages of domestic versus wild stock should ensure relatively rapid development.

By the end of 1986, the Association allocated some 30 million eggs to 85 farms; in 1985, 11 million eggs were distributed to 45 farms.

Brood Stock Development

With the ultimate goal of achieving industry self sufficiency in egg supply the B.C. Salmon Farmers Association launched, in 1985, a two-year \$650,000 program to develop domestic Chinook salmon brood stock.

Participating farms contributed \$400,000 of the cost and the National Research Council \$250,000 through the Program for Industry/Laboratory Projects.

Five salmon farms are participating in the program, which produced some 6 million domestic Chinook eggs in 1986. The program will produce new technological applications that will help to improve domestic egg production in future years.

Marketing Studies

Early in 1986 the B.C. Salmon Farmers Association commissioned a \$50,000 marketing study as a first step toward developing a comprehensive marketing plan for the farmed salmon industry. Ten percent of the cost was borne by the Association with the remaining 90% funded through a joint federal-provincial agreement.

The study has three primary objectives:

1. to examine post-production industrial linkages affecting market access and penetration;
2. to detail strategies and methods in production, distribution and promotion with a view to maximizing returns to farmed salmon producers;
3. to examine Association organization and by-laws in relation to market development targets.

Quality Control and Processing

As an integral part of its marketing strategy, the Association is now developing a "superior" grade standard for farmed salmon, together with quality control and processing regulations to enable continuous monitoring of product quality.

Working in conjunction with representatives of the processing, distribution, transportation and packaging industries, and with regulatory authorities, the Association has developed detailed quality and processing guidelines.

Education

The Association has, since its inception, taken an active role in disseminating information about aquaculture to its members and to interested groups and individuals outside the salmon farming industry. In 1986, for example, the Association, utilizing scientists, expert consultants and experienced salmon farmers, conducted four two-day workshops for farmer members. These comprehensive working sessions dealt with fish nutrition, production strategies, phyto-plankton hazards, processing and quality control.

In addition, Association directors and staff spoke at some fifteen different information seminars organized by groups and individuals interested in aquaculture.

A major responsibility of the newly recruited Director of Information is to increase the Association's information/education activities in 1987 and beyond.

A "TYPICAL" SALMON FARM IN BRITISH COLUMBIA

Experience has shown that to be economically viable as a full-time aquaculture business, a salmon farmer requires the capacity to produce 50,000 fish annually.

To achieve that capacity, the farmer will require a capital investment of approximately \$1 million during the first two years of operation. No revenue from product sales will be generated until the third year of operation.

The farmer would have to place an initial order of 100,000 eggs to ensure production of 50,000 fish. He would require eight 50-foot by 50-foot net pens the first year and an additional eight pens of the same size the second year, plus another 100,000 eggs to start the second crop.

Some 8,000 square feet of surface area (approximately one-fifth of an acre) is required to accommodate the 16 pens. On-shore facilities for housing, feed and equipment storage require perhaps a half-acre of space.

From three to six on-site and management employees are required to operate the farm efficiently.

Expenditures for feed and supplies, excluding pens, salmon eggs or smolts, and on-shore facilities would average approximately \$60,000 in the first year and \$200,000 in the second year of operation.

In British Columbia today, the size of operating salmon farms ranges from some 40,000 fish produced annually to the large integrated operations that produce upwards of 1 million fish per year.

THE ECONOMIC IMPACT OF SALMON FARMING IN BRITISH COLUMBIA

The Association has not yet had an opportunity to develop detailed data on the economic and financial contribution generated by salmon farming in British Columbia. This matter will be addressed as part of the Association's expanding service capability in 1987. We have, however, canvassed industry members, financial institutions and investors and have developed order of magnitude numbers that we feel accurately describe the scope of the industry in today's economy.

The 75 farms now in operation represent a direct capital investment of some \$75 million. Upwards of 40% of that total has been provided by foreign investors, largely from Norwegian banks, where understanding of the salmon farming industry is more highly developed than among Canadian financial institutions.

Operating farms now provide direct employment for some 375 people and spend an estimated \$50 million on services and supplies annually.

Of particular note is the fact that many of the farms now established and planned are near coastal and island communities that have relied historically on one primary economic generator, such as logging, fishing, tourism, etc. The advent of aquaculture broadens the economic base and growth potential of such communities.

If the industry continues to grow at current rates salmon farming will, within two years, develop into a major component of the provincial economy and contribute positively to Canada's balance of payments through export sales.

Based on egg orders now in hand and on the number of licence applications now in process and pending, the industry will by 1988:

- have capital investment in excess of \$200 million;
- employ 2,000 people directly;
- generate some \$250 million in product export sales.

Indirect Benefits

A full economic impact model would be required to identify all of the indirect economic benefits generated by salmon farming industry activity. Some indirect benefits are already evident.

1. Every new job created by direct employment in salmon farming generates at least two additional new jobs in related service industries.
2. The growth of British Columbia's salmon farming industry is directly responsible for the emergence of a strong fish feed industry in the province: two new mills commenced manufacturing during 1986 and two major European manufacturers purchased existing suppliers and are broadening their range of product supplies.
3. Manufacturers and suppliers of nets, pens, construction materials and other related equipment and supplies report significant increases in sales.

One benefit of particular note will be the increased activity for fish processing plants when farmed salmon product moves to market in larger volume in 1987 and 1988.

Salmon farmers typically process and market their product in the period December 1 through May 31, a time when the commercial fishery is largely idle and processing plants have low or no volume.

Increasing volumes of farmed salmon will contribute strongly to higher activity levels in the processing sector.

ENVIRONMENTAL IMPACTS OF SALMON FARMING

The farming of salmon, like any other type of farming, unavoidably impacts to some degree on its immediate environment. However, if the pen sites are properly selected, and the farmer utilizes sound management and production techniques, negative environmental impacts will be minimal. This fact is not widely known in the public mind, which tends to view the concentration of fish in pens as a source of pollution and/or disease.

The primary responsibility of any farmer, whether land or water based, is to prevent and/or control so far as is possible any negative risk to his crop, and thus his livelihood, and to ensure that his activities pose minimal or no risk to the environment shared with others.

One of the principal thrusts of the B.C. Salmon Farmers Association is to increase public understanding and awareness of the real environmental facts of salmon farming.

All of the material in this Environmental Section has been developed in conjunction with members of the scientific community, who are credited for their work in each case.

Fish Disease Transference

Claims have been made that fish disease originating in salmon farm pens transfers to and infects wild salmon stock.

At the request of the Association, Dr. Stephen G. Newman, a microbiology consultant with Microtek Research and Development Limited, Sidney, B.C. examined the question of disease transference. Dr. Newman obtained his Ph.D. in Microbiology from the University of Miami, Miami, Florida; served for seven years as Director of Microbiology Research and Development for Biomed Research Laboratories in Seattle, Washington and has extensive industry experience in fish pathology, immunology, physiology and culture.

Dr. Newman has the following comments on disease transference:

"The following excerpt was taken from Aquaculture Digest, a monthly report on Fish and Shellfish Farming, December 1986 issue.

'Some concern has been expressed that the culture environment may serve as a reservoir for those diseases which are present in the environment but demonstrating no clinical symptoms in wild fish. There is a fear that the disease organisms may proliferate among the cultured fish, become more virulent and

re-infect the wild stocks. However, there is no evidence to indicate that this scenario has ever occurred. The outbreak of a disease is often associated with some form of stress. In the culture environment, fish may be stressed by overcrowding, undernourishment, poor water quality and physical damage associated with handling and confinement. Thus, 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.'

(Abstracted from a study entitled "The Environmental Effects of Floating Mariculture on Puget Sound" prepared for the Washington Department of Fisheries and the Washington Department of Ecology by the University of Washington.)

One of the conclusions reached by this study was that the capacity of a mariculture operation to serve as a disease reservoir for the infection of wild organisms has never been demonstrated and that the existence of such an effect remains largely speculative. There are a number of very good reasons why the spread of disease from cultured fish to wild fish has not been observed and why it is unlikely to occur.

Infectious disease in all animals, including fish, is a result of an interaction between the host, the organism that has the ability to produce the disease and the environment that the animal (fish) is being reared in. How these factors interplay determines the type, severity and incidence of the disease.

For disease to occur, the disease producing organism must have a susceptible host. This susceptibility is determined by many factors and can vary considerably even within a single population of fish. There must also be some means for the pathogen to be transmitted from fish to fish either through intermediate vectors (parasites), the environment, feed, etc. Finally, assuming that the host is susceptible to the disease, then the environmental conditions must be such that a disease process can occur. Each component of this interactive process must be just right for the disease process to occur.

For fish, the single most important component in disease appears to be the environment. Fish can tolerate narrow ranges of environmental fluctuations (such as temperature variations, loading densities, handling, etc.) without becoming stressed. All net pen reared fish are stressed at various times during their growth cycles.

Continual stress is a normal part of the process in some net pen operations. The presence of stress and the subsequent physiological effects on the fish are directly responsible for most of the disease that occurs in net pen operations. Unlike wild fish populations, net pen reared fish don't have the option of thinning themselves out or avoiding excessively warm water temperatures or poor water quality. Since the stresses that correlate strongly with the onset of disease in commercially reared fish don't affect wild populations, wild populations are much less susceptible to disease.

Two of the organisms that can cause a problem to aquaculturists, the etiologic agents of Bacterial Kidney Disease and Infectious Hematopoietic Necrosis, are transmitted principally from adult carriers to fry through infected eggs. Thus transmission of the diseases via these routes of infection to wild stocks is not likely. Screening programs on brood fish, as currently practiced, can significantly minimize the impact of these organisms on commercial stocks.

These disease organisms can be transmitted by other routes though these are not usually significant sources of disease. Since neither organism survives very long in the environment outside of the host, the chances of them being transmitted to wild fish that come in proximity to net pens during disease outbreaks is minimal.

It is noteworthy that these organisms are endemic in wild stocks, though at very low levels. As both of these pathogens require the fish for survival in the environment, the wild stocks are likely the source of these diseases in commercial stocks. These organisms proliferated in wild fish long before the advent of aquaculture. Since wild stocks are often the source of eggs and milt for the initiation of commercial broodstock programs, commercially reared fish (using improperly screened eggs and milt from wild stocks) will continue to have problems with these disease organisms.

Two of the other diseases that cause problems in net pen reared fish are due to bacteria that cause disease primarily in stressed animals. These organisms, responsible for vibriosis and furunculosis, may be present in the fish without ever producing disease. They are not normally found in adult wild animals. It is only when the fish are stressed that the disease process occurs. Sick fish may shed organisms into their immediate environment from lesions and infected fecal material, increasing the chances that fish in close proximity to sick fish will contact a high enough level of pathogens to produce disease.

These pathogens must be present in net pens at very high levels to initiate disease. There is usually a threshold level of micro-organisms below which disease is unlikely to occur. As one moves away from the environment of the net pen, the level of potential pathogens present decreases rapidly. In fact, it is not uncommon for disease outbreaks to occur in a single net pen and net pens that are adjacent to this net pen to have no disease outbreak. The possibility of the disease being transmitted to wild stocks in close proximity to the net pens during a disease outbreak is very small. Even if wild stocks were to encounter a sufficiently high enough level of organisms capable of producing disease in stressed commercial stocks, there are so many factors involved that affect susceptibility, including the presence of stress, that the chances of the disease occurring in the wild stocks is very small.

A final point to consider is the fact that wild fish stocks do not usually congregate around net pens. They may be in contact with waters that have net pens in them, but generally only for very short periods of time during migrations. This usually would occur only if the net pens are situated such that the fish must pass near to them to migrate to the open ocean or to return to spawn. These migrations do not occur at times of the year when environmental conditions are such that the fish in net pens are predisposed to becoming diseased.

To summarize, the transmission of disease from cultured to wild stocks in sufficient magnitude to adversely affect wild stocks is highly unlikely. The nature of the disease organisms, the role of stress in the increased susceptibility of commercial stocks to disease and the migration patterns of wild stocks all substantiate this. Furthermore, the lack of any direct evidence that disease transmission from commercial to wild stocks has ever occurred suggests that this is an issue of little or no concern when considering the potential impact of commercial aquaculture on 'natural' populations."

Stephen G. Newman, Ph.D.

Use of Pharmaceuticals in Salmon Farming

Some concern has been expressed about the environmental impacts of pharmaceutical products used in salmon farming.

Two factual statements address this concern:

1. No scientific evidence has yet been presented to indicate that pharmaceuticals used in salmon farming create risk or threat to human health, or diminish in any way the nutritional value, appearance or taste of the salmon product.
2. No scientific evidence has yet been presented to demonstrate that pharmaceuticals used in salmon farming are harmful to or pose any threat to proximate marine life or foreshore environments.

These and other environmental facts notwithstanding, the B.C. Salmon Farmers Association fully supports the principle of continuous, scientifically sound monitoring of, and action on, the environmental impacts of all ocean and foreshore based seeding, nurturing and harvesting of ocean resources.

Impact of Salmon Farming on Marine Water Quality

One of the most commonly expressed concerns about salmon farming is its potentially negative impact on water quality. Early in 1987, the Ministry of Agriculture and Fisheries released the results of a scientific study conducted in March 1986 in the Sechelt Inlet. The following abstract is reprinted from Fisheries Development Paper Number 11, by E.A. Black and B.L. Carswell.

"Considerable development of mariculture in Sechelt Inlet is projected for the next few years. Salmon farms having a total capacity of at least 4,500 tonnes have been proposed for Sechelt Inlet.

A study was conducted to determine the present level of salmon farming activity was having on water quality in the Inlet and to establish baseline levels for future water quality assessments. Samples were collected during March 1986 at salmon farm sites and compared with those taken from nearshore and mid-channel stations.

Water quality parameters measured included ammonia, nitrite and nitrate nitrogen, orthophosphate, total phosphorus, oxygen, 5 day biochemical and chemical oxygen demands, total coliforms, temperature, salinity, pH and non-filterable residue. While most parameters were comparable to historical ranges for Sechelt Inlet or the Strait of Georgia, two parameters, ammonia and total coliforms, were significantly higher at farm sites than at other sample locations.

Although salmonid excretion must contribute to the elevated ammonia levels, observations suggest that bivalve fouling may make a more significant contribution to the observed ammonia levels. The data also indicates that contaminated salmon feed may not be responsible for the elevated coliform levels near the pens. Proposed sources for the elevated coliforms

are marine birds or mammals. These findings are consistent with data available on other sites.

Water circulation patterns in Sechart Inlet are inferred from available physical and chemical oceanographic data. They indicate longer retention times of water in certain areas, particularly the southernmost portion of Sechart Inlet from Nine Mile Point to Porpoise Bay.

Available evidence thus suggests that at present production levels the existing salmon farms have little effect on surrounding water quality. The data collected may reasonably be used as a baseline for comparison for future studies."

Importation of Live Salmonids

Since 1919 the Department of Fisheries and Oceans has made several unsuccessful attempts to transplant Atlantic salmon into Pacific waters.

For the salmon farmer, Atlantic salmon may have advantages over Pacific species: there are indications that Atlantics have faster growth rates than Pacific Chinook and Coho and Atlantics are more docile and thus less subject to stress and related disease.

Atlantic salmon have been actively cultivated in Puget Sound, Washington state, for a number of years. The first successful transplantation into B.C. waters occurred in 1985 at D.F.O.'s Pacific Biological Station at Nanaimo and at one salmon farm. Three B.C. farms are now growing-out Atlantic salmon.

Concern has been expressed about possible negative environmental impacts resulting from the importation of Atlantic salmon. The Association shares some of those concerns and is monitoring closely the development and behavior of the Atlantic salmon that have been brought into Pacific waters.

The federal Department of Fisheries and Oceans has developed a set of stringent guidelines governing such importations. The guidelines will become formal policy and practice when signed by D.F.O. and by the B.C. Ministry of Environment.

It is worth noting that Atlantic salmonid imported to date have been governed by the guidelines established.

LICENCE APPLICATION PROCEDURES

The licence application process is long and cumbersome, requiring from nine to twelve months from site selection to issuance of the final permits.

A total of eight regulatory authorities from three governmental jurisdictions are involved in the process, as summarized below.

<u>Licence/Permit</u>	<u>Jurisdiction</u>
Section 10 Licence	Ministry of Agriculture & Fisheries (Prov)
Foreshore Lease or Licence of Occupation	Ministry of Forests & Lands (Prov)
Bona Fide Aquaculturist Certificate	Ministry of Agriculture & Fisheries (Prov)
Aquaculture Permit	Department of Fisheries and Oceans (Fed)
Navigation Compliance Permit	Transport Canada (Fed)
Fish Transfer Licence	Inter-Departmental Committee
Business Licence	Municipal or Regional District
Local Building, Sewage, etc. Permits	Municipal or Regional District

Applications for foreshore leases or licences of occupation are advertised to the public. Municipal or regional governments may also advertise applications for business licences, building permits, etc.

An applicant will pay some \$2,000 in licence and permit fees to the various levels of government involved.

MARKETS FOR FARMED SALMON AND WILD SALMON

Some segments of the commercial fishing industry have expressed fears that salmon farming threatens the future viability of commercial salmon fishing. The following excerpts from the independent study commissioned by B.C.S.F.A. addresses these fears.

"The traditional Pacific salmon industry has been increasingly concerned about potential competition from pen-reared salmon in British Columbia and other parts of the world. Industry members are concerned with, among other things, how imports will affect existing markets for wild Pacific salmon. A considerable body of evidence supports two important conclusions:

1. B.C. pen-reared salmon will compete only minimally with B.C. wild salmon production;

2. increasing consumption of fresh (and frozen) seafood generally means that increased consumption of farmed salmon will not be at the expense of wild-caught salmon.

The supporting evidence for these conclusions is provided in the paragraphs that follow.

Total production of salmon in British Columbia for 1984 and 1985 is shown in the following table.

Production of Wild Salmon in British Columbia
(tonnes)

	<u>1985</u>	<u>1984</u>
Chinook	5,461	6,211
Coho	8,977	10,089
Sockeye	31,561	12,877
Pink	37,701	12,059
Chum	23,541	9,003
Steelhead	<u>201</u>	<u>150</u>
Total	<u>107,561</u>	<u>50,432</u>

Source: B.C. Ministry of Environment

As the table above illustrates, the majority of production in B.C. is sockeye, pink and chum. Combined chinook and coho production was 13% in 1985 and 32% in 1984. These two species are the predominant farmed varieties.

Salmon markets can be distinguished on the basis of product form, season and, to some extent, species. There is considerable evidence that the various product forms of salmon do not compete with each other.

Canned salmon competes with other canned products like tuna. Similarly, fresh B.C. salmon competes with fresh salmon from other sources and other forms of fresh seafood. Fresh and frozen salmon do not generally compete with each other in most markets. A restaurant that cannot purchase fresh salmon will seek other forms of fresh seafood, not frozen salmon, as a substitute.

Product form is important for an understanding of salmon markets. The following table provides a breakdown of production by product form for 1984 and 1985.

Production of Salmon by Product Form in British Columbia
(round weight equivalents in tonnes)

	<u>1985</u>	<u>1984</u>
Canned*	60,344	21,168
Fresh†	3,078	2,975
Frozen†	38,312	24,824
Other Forms	<u>5,829</u>	<u>1,465</u>
Total	<u>107,563</u>	<u>50,432</u>

* Canned salmon is converted to round weights @ 70 lbs/case.

† Fresh and frozen dressed salmon is converted to round weight assuming a 90% yield.

Source: B.C. Ministry of Environment

As shown in the table above, a significant proportion of salmon is canned. Canned salmon typically utilizes lower grades of pink and sockeye salmon and sells for considerably less than fresh and frozen salmon. In contrast, the majority of chinook, coho and chum is sold in fresh or frozen form. Farmed chinook and coho compete in the fresh/frozen salmon market. The markets for fresh/frozen salmon in B.C. in 1985 are shown in the following table.

Markets for B.C. Fresh/Frozen Salmon Production in 1985
(tonnes)

	<u>Fresh</u>	<u>Frozen</u>	<u>Total</u>
<u>Domestic</u> ¹	1,180	9,191	10,371
<u>Exports</u> ²			
U.S.A.	1,675	3,530	5,205
Europe	-	14,059	14,059
Japan	-	11,365	11,365
Other	<u>223</u>	<u>167</u>	<u>390</u>
Subtotal	1,898	29,121	31,019
Total	<u>3,078</u>	<u>38,312</u>	<u>41,390</u>
	7%	93%	100%

Source: ¹ B.C. Ministry of Environment; ² Statistics Canada

The table above highlights the following factors important to an understanding of the markets for fresh and frozen salmon:

- frozen salmon comprises 93% of total fresh/frozen production, the majority of which is exported to Europe and Japan;
- fresh salmon production comprises 7% of total fresh/frozen production, the majority of which is exported to the U.S.A.

The table illustrates that fresh sales of B.C. wild salmon constitute a very small proportion of total salmon production. Moreover, there is considerable evidence that this fresh production alone is, by and large, the only portion of B.C. catch that will compete with B.C. farmed salmon.

The conclusions of a major study conducted by the University of Alaska and completed in September, 1986 reinforces this finding. The study, which included a survey of 127 wholesalers in the major salmon markets of Los Angeles, San Francisco, Seattle, Chicago, New York and Boston, was commissioned because of concern about the impacts of U.S. imports of fresh Atlantic salmon from Norway on markets for wild-caught Pacific salmon. One of the important findings of the survey was that the majority of wholesalers and distributors who handle pen-raised salmon feel their product competes only with fresh wild Pacifics.¹

Seventy-five percent of respondents contended that pen-raised salmon were not a legitimate substitute for frozen wild Pacific salmon, (i.e., did not compete with) while 80% felt that fresh wild Pacific salmon and pen-raised salmon were substitutes.

Given the fact that only 1% of Alaskan catch is marketed fresh, the authors concluded, on the basis of the survey evidence, that "some of the concern about pen-raised salmon imports shown by Alaskan commercial salmon fishermen may be somewhat unwarranted".

This viewpoint is further reinforced in a recent article contained in a leading seafood industry journal.² Based on interviews with brokers and producers, the authors concluded that competition at current price levels was minimal. It was contended that most restaurants that handled a fresh cultured product would be unlikely to offer salmon if they had to resort to frozen fish. Some industry observers quoted in the article conceded that farmed fish expanded the market "by keeping fresh salmon on consumers' minds during the off-season".

Other factors, listed as follows, lead to the same conclusion.

- fresh wild caught exports to the U.S.A. have not decreased since the introduction of farmed salmon into British Columbia (see below);
- the vast majority of British Columbia farmed salmon is and will be sold in the months when fresh wild-caught salmon is not available;

- most farmed salmon is priced above fresh and frozen wild-caught salmon, suggesting that there is minimal price competition.

Furthermore, with respect to prices, there is no indication that the introduction of farmed salmon has had an impact on prices for wild-caught salmon. Average wholesale prices for fresh and frozen chinook and coho for the period 1981-1985 are shown in the following table.

**Average Wholesale Prices
of Fresh and Frozen Chinook and Coho
1981 - 1985
(\$/kg)**

	Fresh		Frozen	
	Chinook	Coho	Chinook	Coho
1981	6.46	5.68	8.30	6.41
1982	6.92	4.78	8.33	6.17
1983	6.29	4.49	7.51	4.91
1984	8.03	6.24	9.31	7.12
1985	7.89	5.79	9.78	6.84

Source: B.C. Ministry of the Environment

The prices indicated in the table above suggest that demand for fresh and frozen wild-caught salmon remains strong. Some industry observers suggest that the introduction of farmed salmon has had a positive impact on prices for wild-caught salmon.

The vagaries of the export market, in particular exchange rates, present a much greater challenge to traditional salmon producers in B.C. than incursions on their markets by B.C. farmed salmon. Where wild B.C. Pacific salmon stands to lose a substantial market share is in the smoking markets in Europe where farmed Atlantic salmon production from Norway and Scotland has recently eroded market shares held by Canadian and American frozen Pacific salmon.

It is unlikely that B.C. farmed salmon will be exported to Europe because of the transportation disadvantages. Rather, B.C. farmed salmon sales will likely be mostly in the U.S.A.

The U.S.A., in spite of having large domestic supplies and being the dominant exporter, is also the world's largest importer of fresh salmon. A comparison of American imports of fresh and frozen wild and farmed salmon in 1981 and 1984 is shown in the following table.

U.S.A. Imports of Fresh Wild and Farmed Salmon *
(tonnes)

	Fresh		Frozen	
	1981	1984	1981	1984
Canada	591	2,522	1,946	2,542
Norway	5	3,888	8	80
U.K.	-	104	-	-
Chile	-	32	-	-
Others	2	279	44	122
Total	598	6,825	1,998	2,744

* excludes fresh fillets

Source: U.S. Department of Commerce

As indicated in the table above, both fresh and frozen imports have increased. As well, Norway has replaced Canada as the leading exporter of fresh salmon to the U.S.A. With the exception of Canada, imports were mostly farmed salmon.

So, while the size of the fresh salmon market has grown dramatically since 1981, it has not been at the expense of fresh or frozen wild-caught production from British Columbia whose exports also increased. Demand for fresh salmon has increased in the U.S.A. because: more outlets have increased availability; demand has been stimulated by greater consumer awareness; and real incomes have been rising.

Most industry observers expect American demand to continue to grow. Suppliers of pen-reared salmon from countries like Canada, Norway, Chile and New Zealand are also rising dramatically.

As a result, the real marketing battle in the future will be fought between various suppliers of farmed salmon, not between farmed and wild sources. And that international competition will exist whether or not B.C. develops a strong salmon farming industry."

FOOTNOTES

- 1 Ernald V. Rogress and Bing-Hwan 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.
- 2 Richard Bard, Salmon: An Ever-Changing Supply, in Seafood Business Report, March/April, 1985.

PROVINCIAL GOVERNMENT SUPPORT OF SALMON FARMING

The Government of the Province of British Columbia has been an active and high-profile proponent of the desirability of developing a vibrant salmon farming/aquaculture industry in this province.

Creation and staffing of aquaculture administrative divisions in appropriate Ministries, supportive advertising programs and other activities all attest to the Provincial Government's positive view of and support for this industry.

Of particular note are the foreign trade missions sponsored and organized by government Ministries in each of the past three years. These missions, composed of industry and government representatives, were designed specifically to obtain first-hand information about salmon farming/aquaculture in other countries and to encourage investment in the developing industry in British Columbia.

In response to some stated concerns about the rapid development of salmon farming in B.C., the provincial government imposed in late 1986 a moratorium on the issuance of salmon farm licences and appointed Mr. David Gillespie to head a 30-day public inquiry into finfish aquaculture in the province.

The B.C. Salmon Farmers Association supported the Inquiry and prepared a major submission to Mr. Gillespie. His report and recommendations were released on December 16, 1986 and the licence moratorium was lifted three days later.

The Association supports the major recommendations of the Gillespie Report and looks forward to assisting government in implementing those recommendations and associated programs.

January 1987

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AQUACULTURE IN ALASKA

ALASKA DEPARTMENT OF
FISH AND GAME
SPECIAL REPORT NO. 10

AQUACULTURE IN ALASKA

Brad Pierce
House Research Agency
Alaska State Legislature
February 1987

House Research Agency Report 87-B

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INTRODUCTION

Aquaculture is a general term which is defined as the cultivation of fin-fish, shellfish and aquatic plants in fresh or saltwater. **Mariculture** refers to the cultivation of plants and animals in saltwater. This distinction is significant because the most controversial form of mariculture development in Alaska--the pen culture of salmon--is intimately connected with the state's hatchery programs and includes a freshwater component.

At the recommendation of his Fisheries Mini-Cabinet, Governor Sheffield appointed an ad hoc Mariculture Advisory Committee on July 15, 1985, consisting of individuals from fishermen organizations, fish processors, a Native corporation, governmental agencies, the universities, and individuals in the private sector interested in mariculture development. The committee was charged with formulating a workable and effective mariculture policy to guide the development of the industry in Alaska. In its policy statement to the Mini-Cabinet titled "A Philosophy for Aquaculture Development in Alaska" (January 20, 1986), the committee expanded its original charge to include culture of all aquatic plants and animals in both the fresh and saltwater environments. We concur with the conceptual scope of the Mariculture Advisory Committee, and have adopted their convention of dividing the issues in aquacultural development into the three general categories of: 1) ocean ranching salmon (i.e., hatcheries); 2) pen rearing salmon; and 3) other forms of mariculture.

There has been a great deal of public interest in aquaculture development in Alaska during the past few years and numerous articles have been published in the popular press on the potential for producing pen-reared salmon and other species such as oysters and mussels. State and federal agencies are studying the biological feasibility as well as the social and economic implications of aquaculture development. Undoubtedly the legislature will hear very competent testimony on all of the issues involved as it considers aquaculture/mariculture legislation in the upcoming session. In this report, we attempt to: 1) guide the reader through the recent research on aquaculture issues in Alaska; 2) convey an overall sense of how these issues relate to each other; and 3) assess their meaning in economic terms to State fisheries policy. It is very easy to lose sight of the ultimate goals of successful fisheries policy in the Byzantine world of Alaska fish politics. We will attempt to separate the long-term factors which affect the competitiveness of Alaska's products in world seafood markets from short-term controversy and try to give the reader a broad frame of reference to accommodate expert testimony on aquaculture issues in the upcoming legislative session.

The appendix lists some of the recent aquaculture research in Alaska from which we have drawn basic information. After reviewing the wealth of available literature and speaking with various researchers involved in

studying aquaculture development, it is clear that even though there are some biological and economic questions which cannot currently be answered with certainty, policymakers presently have an adequate information base for making rational decisions about the future of aquaculture development in the state. It is important to note that all of these research efforts are made in support of administrative and legislative leadership. With the exception of the Sealaska Corporation, none of the agencies involved in studying aquaculture has adopted an advocacy position.

Each chapter of this paper dealing with specific aquaculture issues is well documented; the reader should be able to easily locate references to specific topics. The House Research Agency has collected an extensive library on aquaculture and will respond to specific questions on topics contained in this study.

Chapter One discusses expected trends in worldwide aquaculture production and Alaska's place in it. The unique circumstances of Alaska's situation and colonial legacy of fisheries development are posited as reasons the state is not in the forefront of worldwide aquaculture development. The basic strengths of countries with model aquaculture programs are described and the possible role of State government in future development is outlined.

Chapter Two focuses on Alaska's salmon ocean-ranching program. Ocean-ranching programs in other Pacific Rim countries are described briefly and their impact on markets for Alaska's hatchery-produced salmon are discussed. Alaska's public and private hatchery programs are described in detail. State financial involvement and the benefits/costs of the hatchery programs are examined. Future trends in markets for high-volume salmon species are analyzed. State policy options aimed at maintaining fishermen's incomes are discussed and the possible relationship between Alaska's hatcheries and a salmon-farming industry are described.

Chapter Three focuses on salmon farming. The history of salmon farming and the outlook for future farmed production are described. Premium salmon markets are examined in detail. The role of tariffs and subsidies is analyzed. The structure of the salmon-farming industry in its various forms around the world is examined. The issues surrounding a salmon-farming industry in Alaska are examined in detail. The economics of salmon-farming production are analyzed and the economic impacts of salmon farming in the state are estimated in light of available information.

Chapter Four is devoted to forms of mariculture other than salmon that are underway or proposed in Alaska. Oysters, mussels, scallops and giant kelp mariculture are described. Issues of importance to entrepreneurs and options for State involvement in dealing with them are discussed.

EXECUTIVE SUMMARY

Chapter One--World Aquaculture

World commercial landings of all species of fish and shellfish have remained rather static during the past 15 years. This suggests that naturally occurring stocks are being harvested at or near their upper level of capacity. By the turn of the century, world consumption of fish and shellfish is expected to increase by 33 billion pounds per year. This provides an enormous opportunity for aquaculture development (pp. 1, 2).

The U.S. seafood market is regarded by many in the business as the largest underdeveloped market in the world. The U.S. annual per capita consumption of fish and shellfish grew 13 percent from 12.8 lbs. to 14.5 lbs. between 1980 and 1985 (549 million pound annual increase). This trend is expected to continue as consumers become more knowledgeable about the health benefits of eating seafood and increasingly sophisticated about different species and various methods of preparation (p. 3).

Many experts believe that we are in the early stages of a worldwide "blue revolution" in aquaculture similar to the "green revolution" of the 1960s and early 1970s, which transformed agriculture in developing countries. Just as the "green revolution" turned several food-importing countries from food importers into net food exporters, the "blue revolution" will have profound social and economic consequences as the protein production potential of aquaculture is realized (pp. 1, 4).

Alaska's competitive position in the "blue revolution" of aquaculture development will depend on its comparative advantages in relation to the rest of the world. **Worldwide conditions of supply and demand combined with the economics of production and distribution will ultimately determine which species and markets are feasible for aquaculture products from Alaska** (p. 3).

Alaska's physical potential for aquaculture development is quite large, though narrowly defined. The major physical advantages include enormous natural salmon runs, clean nutrient-rich waters and vast areas of suitable habitat for development. For species other than salmon, cold water temperatures limit varieties that can be cultivated economically (p. 4).

Aquaculture development in Alaska has the economic advantage of a well-developed fisheries infrastructure and access at reasonable cost to rapidly growing domestic seafood markets. The classic economic development triad of cooperation between government, the university system and private industry (which has been one of the key characteristics of successful aquaculture programs in developed countries such as Japan and Norway) already

exists in Alaska. Other sources of strength that we have observed in successful aquaculture programs around the world include the cooperative structure of producer organizations and vertical integration from production through distribution. The aquaculture industry in Alaska lags in these areas. (p. 3).

Compared to salmon, all other potential aquaculture products which could be developed in the near future (within five years) are likely to be of relatively minor economic importance. In the intermediate future (five to ten years), the farming of oysters, mussels, scallops and sea vegetables could substantially diversify the state's aquaculture industry and become important to the economies of coastal communities (p. 4).

The major economic disadvantage to aquaculture development in Alaska is generally high operating costs. While not necessarily a disadvantage, State policy is certainly a significant factor in aquaculture development. The State controls tidelands from mean high water to three miles offshore and the State and federal government control most of the coastal lands in Alaska. Thus, the terms that government agencies set for leasing aquaculture sites and the amount of red tape that operators must wade through to obtain control of the resource can be important factors in the economic viability of aquaculture ventures (p. 4).

Impediments to further aquaculture development are mainly political and legal. The traditional fishing industry is generally receptive to developments such as oyster and mussel farming but more ambivalent toward competing enterprises such as pen rearing salmon. The Sheffield administration policy generally reflected the attitude of the fishing industry and attempted to separate salmon farming from other forms of aquaculture development (p. 4).

The state's colonial history of fisheries development explains much of the political ambivalence of the Alaska fishing industry regarding pen rearing salmon as well as the xenophobic attitude towards developments in other countries (pp. 5 - 10).

Long-term economic prosperity--as expressed by employment, income and profits--in the fishing industry springs from producing as many competitively priced products as possible. To this end, the State's role in setting fisheries policy needs to be oriented toward lowering producer costs to make products from Alaska more competitive in world markets (p. 4).

Fish politics in Alaska (particularly among salmon fishermen's groups) have recently focused inward on narrow allocation issues instead of outward on

new developments in world markets. Instead of actively dominating all segments of world salmon markets, Alaska is experiencing an erosion of its market share, particularly in higher valued products (pp. 9, 10).

There are several legal bottlenecks in State statutes that must be addressed by the legislature for aquacultural diversification to proceed. The present legal situation, as interpreted by the Attorney General's Office, is an impediment to all new forms of aquaculture development. The most pressing need to further aquaculture development in Alaska is a comprehensive State policy which addresses all forms of aquaculture (p. 11).

Chapter 2--Ocean Ranching

The ocean ranching of salmon, i.e., raising smolts in hatcheries and sending them out to sea to return as adults, is and will continue to be the most important aquacultural activity in Alaska. Alaska's system of public and private hatcheries is the key to further diversification in salmon aquaculture (p. 13).

All the major salmon-producing countries in the North Pacific have salmon-ranching programs. It is likely that international disputes over rights to ocean feeding grounds and high seas salmon catches will intensify in the future as producing countries seek to maximize the economic potential of salmon-ranching investments. The market implications of these salmon-ranching programs point to a long-term increase in the world supply of low-value/high-volume species of Pacific salmon, specifically pinks and chums, which are the cheapest and easiest species to raise (pp. 13, 14).

The Hokkaido Salmon Propagation Association offers a concrete example of how the Japanese ocean-ranching system works and is a model of how fishermen's organizations can cope with decreases in government support for aquaculture. The cooperation of individuals within the group is the dominant characteristic and a source of great economic strength and adaptability in the Japanese fishermen's cooperative system. Operating costs are minimized and economic return to members of the Hokkaido cooperative is maximized through a combination of vertical integration from the hatchery through harvesting and marketing of adult fish, substantial amounts of free labor from association members, and use of the most efficient available harvesting methods (pp. 15, 16).

The Japanese have the most cost-effective salmon ocean-ranching program in the world, with benefit/cost ratios for individual chum salmon hatchery programs estimated to range between 16:1 and 33:1 (pp. 14 - 16).

All of the available information on Soviet ocean-ranching programs points to a very large-scale and long-term commitment to hatchery production, particularly of pink and chum salmon. Exports of salmon products are an important source of foreign exchange and are likely to increase in the future (pp. 16, 17).

EXECUTIVE SUMMARY

At its present funding level, the overall benefit/cost ratio for British Columbia salmon hatcheries is estimated to range between 1.31:1 and 1.67:1 (p. 19).

The cornerstone of Alaska's aquaculture industry is the state's unique system of public (FRED) and private nonprofit (PNP) hatcheries. By almost any economic measure, this is probably the best investment in renewable natural resources the State has made with its oil wealth (p. 21).

The impetus for the PNP hatchery system came from the desire of commercial fishermen to enhance the severely depressed salmon stocks of the early 1970s. The program represented an unprecedented partnership among fishermen, processors, legislators and the Governor's Office (p. 31).

The industry requirement of extended payback periods and the uncertainty of returns through the common property fishery are the primary reasons the State is involved in financing PNP hatcheries. The terms offered by the Fisheries Enhancement Revolving Loan Fund are crucial to the viability of PNP hatcheries (p. 37).

In late 1984, Governor Sheffield's Fisheries Mini-Cabinet recommended a freeze on construction loans from the Fisheries Enhancement Revolving Loan Fund pending a review of the costs and benefits of the State's investments in both private and public salmon enhancement projects. This move was prompted by processor complaints of unsold inventories of frozen and canned salmon (particularly pinks and chums) and fishermen's concerns over low ex-vessel prices following five years of near record harvests (p. 39).

It is probable that a pause in the construction of new hatchery production facilities was inevitable given the magnitude (over \$100 million) of the State's investment to date. After publication of a benefit/cost analysis of Alaska's public and private hatchery systems in 1986, the moratorium was lifted for production of species other than pinks and chums (p. 41).

The benefit/cost ratio for Alaska's hatchery system computed by the Department of Fish and Game was estimated to be 1.43:1 with a net present value of production of \$96.5 million. This ratio was based on price forecasting models for the commercial salmon catch that reflect an extraordinarily high dollar exchange rate in foreign markets and very limited data on the value of the state's sport fishery. In our judgment, this benefit/cost ratio significantly underestimates the value to the economy of the State's investment in hatchery facilities (pp. 44, 45).

The major difficulty faced by both regional and nonassociation PNP hatchery operations has been to work out a reasonable harvest management scheme with the Board of Fish and the Division of Commercial Fisheries to assure adequate cost recovery (p. 41).

EXECUTIVE SUMMARY

The Division of Commercial Fisheries is charged with managing salmon harvests to separate natural and hatchery stocks and to assure adequate escapement for natural runs. It is not charged with assuring cost recovery for hatchery operators. FRED, as the regulator of PNP hatcheries, is in somewhat of an advocacy position. Thus, a philosophical conflict often exists between the goals of the two divisions of ADF&G . 41).

The aquaculture assessment tax on the value of the commercial catch and the partial cost recovery/assessment method of financing regional association PNP hatcheries appears to be working fairly well. For nonassociation PNP hatcheries, the financial situation is more precarious. It is probable that some change in the present institutional arrangement for nonassociation hatcheries (e.g., allowing hatcheries to obtain for-profit corporate status or to pen rear salmon and/or sell eggs and smolts to salmon farms) is needed to assure their long-term viability (p. 42).

Product development is beginning to catch up with production in Alaska's low-value/high-volume salmon fisheries. The Department of Commerce and Economic Development, Office of Commercial Fisheries Development has been instrumental in facilitating the transfer of bottomfish technology to the salmon processing industry. We are on the verge of a major breakthrough in product development for pink and chum salmon. Skinless and boneless fillets and minced products will command a higher price in the marketplace and attract new consumers in the intermediate future (five to ten years), which should increase fishermen's and processors' gross incomes (pp. 45 - 47).

State policy decisions--such as the moratorium on loans for hatchery construction--have attempted to maintain fishermen's incomes and processors' profit margins by placing limits on the potential number of pink and chum salmon produced by PNP hatcheries. This indirect method of meeting policy goals is based on questionable assumptions about price/volume relationships in Alaska's salmon markets. **A more direct policy tool for raising fishermen's incomes and improving harvesting efficiency is implementing a limited entry permit buyback program.** A number of changes to State statutes concerning buyback are necessary to make a program workable. The Commercial Fisheries Entry Commission has drafted legislation that would address the legal problems in current statutes (pp. 42, 47, 48).

If a salmon-farming industry in Alaska is allowed to develop, the availability of smolts will be a critical factor in how quickly it can proceed. The most practical means of obtaining eggs and/or smolts for salmon farms would be to purchase them from FRED and PNP hatcheries. This could reduce the cost recovery problems of PNP hatcheries, increase the performance potential of the State's Enhancement Loan portfolio and help to finance expensive wild egg takes to further the genetic diversification of chinook and coho brood stocks. Existing statutes would have to be modified to allow sales of eggs or smolts to occur (pp. 49 - 51).

Chapter 3--Salmon Farming

Salmon farming, which began in Norway and has developed largely since 1970, has become a worldwide growth industry, especially during the past five years. The opening of the U.S. market through air freight and the high value of the dollar relative to European currencies were key factors which accelerated the growth of the industry (p. 53).

Farmed salmon provided slightly over six percent of the world salmon supply in 1985 and may reach 14 percent by 1990. Norway is expected to be the dominant producer of farmed Atlantic salmon, accounting for about 80 percent of total production. British Columbia is becoming the main focus of Pacific salmon farming, but Chilean, Japanese and New Zealand production are also rapidly expanding (p. 56).

By 1990, farmed production is expected to dominate world trading in both fresh and frozen premium markets. As new markets for farmed salmon are opened and lower cost producers enter the supply picture, price competition could escalate. New producers who have unamortized development costs and have not gotten production costs under control would be particularly vulnerable to price cutting by lesser developed countries such as Chile (which has extremely low labor and feed costs) (p. 56).

While there is no doubt that farmed salmon has had broad and irreversible effects on premium salmon markets worldwide, the impact is fairly complex and interactions between market segments are difficult to sort out. Government subsidies, tariffs, relative exchange rates, changing consumer tastes and preferences, and rapid structural change in seafood markets complicate--and to a certain extent defy--conventional economic analysis. Just as no one foresaw the incredible increase in demand and production of farmed salmon in the 1980s, it would be unrealistic to project current trends in sales and production beyond the 1990s (p. 58).

On a value comparison basis, Norway earned approximately \$180 million on sales of farmed salmon in 1985 (five percent of world salmon production), while the record 1985 Alaska salmon harvest of 144.6 million fish (43 percent of world salmon production) earned \$370 million (p. 58).

Thus far, farmed salmon have been primarily aimed at the "top of the market" and sold through traditional fresh fish channels to the catering sector, smokers and certain retail markets. The next major challenge for producers will be to penetrate further into the mass retail segment of fresh and frozen markets and win acceptance with the great bulk of consumers (p. 58).

According to a recent survey of domestic seafood wholesalers, a majority of firms that handle pan-sized farmed cohos do not consider them to be a legitimate substitute for fresh or frozen adult wild Pacific salmon. However, fresh farmed adult Atlantic salmon are viewed as a close substitute for fresh wild Pacific salmon. The marked seasonality of imports of pen-reared Atlantics, which corresponds to the unavailability of Pacific species during winter months, is becoming less of a factor over time. Many firms now make their purchases of Atlantic salmon independent of the availability of fresh wild Pacific salmon (pp. 58, 59).

It appears that frozen farmed Atlantic salmon do not currently substitute for frozen Pacific salmon. Since about 97 percent of the harvest of premium species (coho, sockeye and chinook) in Alaska is sold frozen, this indicates that farmed Atlantic salmon compete only marginally in the same domestic markets as wild Pacific fish from Alaska. This situation is probably only temporary; the enormous increase in farmed production forecast by 1990 will inevitably drive down prices so that farmed Atlantics will compete directly with wild Pacific species in frozen markets (p. 60).

The domestic catering sector is where farmed salmon has enjoyed its greatest market penetration. The most significant marketing criteria in this market appear to be high quality, freshness, uniform sizing, consistent pricing and continuity of supply. There appears to be major room for expansion of sales of fresh and frozen farmed salmon (both pan-sized and adult fish), particularly for prime quality frozen products in higher volume "family restaurant" outlets, where ease of preparation is a prime consideration (p. 60).

The smoking market is very important for farmed salmon. By 1980, European smokers began switching from frozen wild species to farmed Atlantic salmon because they could buy fresh product as needed and avoid or minimize risky inventory decisions with associated borrowing and energy costs. Another reason was consistently higher average quality in farmed as opposed to wild fish. There appears to be a significant opportunity for farmed salmon in domestic smoker markets (pp. 61, 62).

Multiple retail outlets are buying increasing quantities of fresh farmed salmon in Europe and potentially offer a huge market in North America. Farmed production fits in with the ability of these stores to plan, schedule and market large fresh product volumes of consistent quality and price over long periods each year. Farmed salmon of specific quality and size can be purchased via long-term, fixed price contracts. The key to further growth in this market appears to be lower prices for adult farmed salmon, particularly relative to pan-sized fish (p. 62).

In general, there appears to be a geographic component to domestic product differentiation between fresh farmed Atlantic and wild Pacific species, with West Coast consumers preferring the larger size and deep red colored flesh of premium Pacific species (pp. 62, 63).

EXECUTIVE SUMMARY

Eliminating middlemen, reducing freight costs and minimizing exchange rate fluctuations are all reasons that established foreign salmon-farming companies wish to invest in the U.S. and Canada (pp. 63 - 65).

The structure of the salmon-farming industry in its various forms around the world has evolved in response to physical constraints (i.e., the quality and quantity of available sites) and government objectives such as employment in coastal communities (p. 66).

Marine pen-rearing operations in Washington State have been strongly opposed by real estate developers and waterfront homeowners who object to their presence on aesthetic grounds (usually under the guise of "environmental concerns"). It is most likely that the rapidly expanding salmon-farming industry in British Columbia will become the main competitor for a salmon-farming industry in Alaska (p. 67).

A kind of Klondike gold rush atmosphere pervades the wildly speculative growth of the British Columbia salmon-farming industry, with a significant portion of the investment capital coming from foreign--mainly Scandinavian--banks. A painful shakeout of independent farmers who do not have an assured source of smolts and are not tied to a marketing entity is likely to ensue in the near future (pp. 68, 69).

The Prince Rupert Fisherman's Cooperative is a model of how a group of traditional North American fishermen can successfully integrate salmon farming into their operations to take advantage of new developments in seafood markets. Members will market their farmed fish in the off season to supplement their wild fish in season. The cooperative produces smolts and fish food for its members and is experimenting with various types of shellfish for farming application. The combination of technical and research capability with managerial know how and vertically integrated operations makes the cooperative an extremely powerful and adaptive economic unit (pp. 69, 70).

The carefully controlled development of the Norwegian salmon-farming industry stands in sharp contrast to the free-for-all atmosphere of British Columbia. Many of the pioneers of Norwegian salmon farming were small businessmen and fishermen on the coast. The Norwegian program has been highly successful at realizing the government's goals of providing and promoting economic development in depressed coastal economies, with a total employment effect of 4,000 jobs in the industry (p. 70, 71).

Points most frequently mentioned by industry observers as the major comparative advantages to salmon farming in Alaska are site availability, the relatively short distance to domestic markets and the lack of international boundaries to cross (p. 72).

EXECUTIVE SUMMARY

The availability of smolts and locally produced feed are likely to be critical production constraints in Alaska (as they have been elsewhere) and the ability to obtain financing and insurance is likely to be crucial to the development of family-run operations. The hatchery capacity of FRED and PNP systems in Alaska is a distinct advantage over the situation in British Columbia (p. 73).

There appears to be a consensus among proponents of aquaculture that since the development of all mariculture species except oysters is in legal limbo in Alaska, a comprehensive overhaul of the appropriate statutes is desirable. A permitting process that applies to all forms of mariculture (including multi-species operations) is also highly desirable, but policy decisions on the number, size and location of mariculture sites is critical to the further development of a reasonable permitting procedure (p. 74).

American banks and insurance companies have little or no experience with aquaculture, so at least some financing of salmon farms would likely come from foreign investment. Outside investment in aquaculture is qualitatively different from that in traditional fisheries because it creates year-round employment and promotes greater use of underutilized processing facilities (p. 76).

The Fisheries Enhancement Revolving Loan Fund will be receiving large payments from hatchery operators in the near future as many PNP hatcheries reach the end of their deferred payment schedule and begin to repay their construction loans. This income stream could be a means of financing the diversification of Alaska's aquaculture industry to include salmon farms and other forms of mariculture (p. 76).

The greatest danger from importing nonindigenous (i.e., Atlantic salmon smolts or eggs) species into Alaska is the possibility of also importing diseases. This has been a major problem in the Norwegian salmon-farming industry. There are several precedents for importing nonindigenous species into Alaska, but the risks must be carefully weighed against the potential benefits. The zero-age chinook technique developed by FRED could be an important development for a salmon-farming industry in Alaska (p. 78, 79).

Feed costs comprise the largest component of total operating costs in salmon farming. It is very unlikely that a farmer could profitably pen rear salmon at prevailing feed costs in Alaska. Dry pellet feed costs would probably need to drop from the present \$0.55 per pound to the \$0.30-\$0.40/lb. range for pen rearing to be profitable. The economies of scale in feed production in Alaska are not well known, but even a small farming industry could support more than one feed plant (p. 79, 80).

The economics of salmon farming in Alaska have not been studied in depth. A 20,000 metric ton salmon-farming industry in the state could realistically produce a total employment effect of about 1,920 jobs and a payroll

of \$48.8 million on gross sales of \$132 million. A salmon-farming industry of this magnitude would have an economic impact that is roughly comparable to the present Alaska logging industry in terms of employment (pp. 80 - 84).

Salmon farming is a particularly appealing industry for Native regional and village corporations with large coastal landholdings. It uses the skills of local residents and brings in year-round income. At least two Indian tribes in Puget Sound are involved in salmon farming. Vertically integrated companies such as Sealaska Corporation could become the nucleus of technical, financial and marketing support to a large number of satellite farming operations (p. 84).

Given Alaska's comparative advantages as a salmon producer, ocean ranching is the State's first investment choice. Salmon farming is the next logical State investment in salmon aquaculture. Failure to invest in salmon farming could result in : 1) a steady erosion of Alaska's market share in premium salmon markets; 2) underutilized processing facilities (and corresponding loss of potential jobs); and 3) a PNP hatchery system that may not be able to generate sufficient revenues (under current operating constraints) to repay its State loans and attain financial self-sufficiency (p. 85).

Alaska fishermen will face competition from farmed salmon regardless of whether or not they come from farms in Alaska. There is a limited "window of opportunity" for Alaska to enter salmon farming and gain a market share (p. 85).

Chapter 4--Other Forms of Mariculture

Species other than salmon which are presently being pursued or contemplated for mariculture development in Alaska are: oysters, mussels, scallops and giant kelp (p. 87).

Oysters only rarely spawn naturally in Alaska. Because they do not generally spawn, oysters grown in the state's waters remain fat and succulent and do not become mushy and bitter as they do in regions where spawning occurs (p. 87).

The lack of locally produced oyster larvae requires that juveniles (spat) be purchased from oyster hatcheries outside the state. The importation of live oysters is specifically regulated by the Board of Fisheries, which allows only commercially cultured oysters from the Pacific Coast of North America to be imported into the state (pp. 87, 88).

There are 20 permitted oyster farms in Alaska; with seven currently producing oysters for commercial sale. Oyster farmers enjoy a market situation where demand is increasing and production declining because of water quality problems experienced by producers outside Alaska (p. 88).

EXECUTIVE SUMMARY

Oyster farmers stress three things they need from the State for orderly development of their industry to proceed: 1) an oyster hatchery; 2) conveniently located paralytic shellfish poisoning (PSP) testing facilities; and 3) a loan program (pp. 88, 89).

Many of the developmental concerns of Alaska shellfish farmers focus on the present Department of Natural Resources (DNR) site permit regulations. The current site permit process was designed for the logging industry (log transfer sites) and is full of uncertainties for shellfish farmers (p. 89).

Blue mussels are indigenous species found throughout coastal Alaska. There are large and growing markets in North America and Europe for mussels. Presently there are five permitted mussel farms in Alaska, with one producing mussels in commercial quantities. Mussel farmers are currently operating under clam shovel licenses because the Division of Commercial Fisheries has made a very liberal interpretation of regulations (p. 91).

Mussel culture is an ideal family-type enterprise which could be practiced in many suitable coastal regions of the state. Combined with the cultivation of other species, it can allow a small operator to make a comfortable living and enjoy a remote lifestyle (p. 92).

The transportation delay for shellfish operators in Alaska to get their samples tested for PSP is a serious problem, but it is not clear that the solution is simply to build more testing labs. From the Department of Environmental Conservation's budgetary perspective, the centralized testing lab is the most cost-effective means of providing PSP testing. As the scale of farmed shellfish production increases, satellite labs (perhaps in the Homer-Kodiak area and Southeast) may become viable (pp. 93, 94).

There are currently four permitted scallop larvae collection efforts underway in the waters around Kodiak which are targeting on the weather-vane scallop. Kodiak has some of the richest scallop-growing habitat in the world. The stable price of scallops and growing domestic shellfish market makes it a very attractive species for mariculture. In recognition of these facts, the Japanese Overseas Development Foundation is cooperatively funding (along with State and local agencies) the current research efforts. The current scallop spat collection effort has been underway for less than a year and has thus far been unsuccessful (pp. 94, 95).

The herring roe-on-kelp fishery could serve as the basis for giant kelp mariculture in Alaska. A major concern in the management of the current roe-on-kelp pound fishery (where herring spawn on suspended kelp fronds contained within a net or pound) is the potential for overharvesting the kelp resource. The State of Alaska and Japan have agreed to a joint three-year study of the feasibility of giant kelp mariculture in Southeast (p. 96).

EXECUTIVE SUMMARY

The pound fishery offers an attractive alternative to the sac roe fisheries because the adult herring are not killed and a much higher valued product is produced. It appears that while kelp farmers could have a good roe-on-kelp market, the ultimate feasibility of giant kelp mariculture in Alaska will probably depend on locating an adequate roe-herring resource that is not presently being fully utilized by traditional fisheries (pp.98, 99).

CHAPTER ONE

WORLD AQUACULTURE

THE BIG PICTURE

World commercial fisheries landings (i.e., fish captured from the sea) of natural or wild stocks of all species have remained rather static at 70 to 75 million metric tons (158 billion pounds, in 1983) during the past 15 years subject to minor annual fluctuations.¹ An annual average increase in landings of only 0.3 percent is forecast through 2010 (171 billion pounds) by the National Marine Fisheries Service (NMFS).² This suggests that, despite many improvements in harvesting technology in recent years, fish are being harvested at or near their natural upper level of capacity.

By 1983, world commercial fisheries landings accounted for 87.8 percent of total world production of fish and shellfish while aquaculture accounted for the remaining 12.2 percent.³ The NMFS expects the commercial fisheries component to slip to 80.5 percent by 2000 and 75.7 percent by 2010. In contrast to the meager 0.3 percent annual increase in commercial fisheries landings, world aquaculture production is expected to increase at a 5.5 percent annual rate over the next 25 years (see Figure 1).

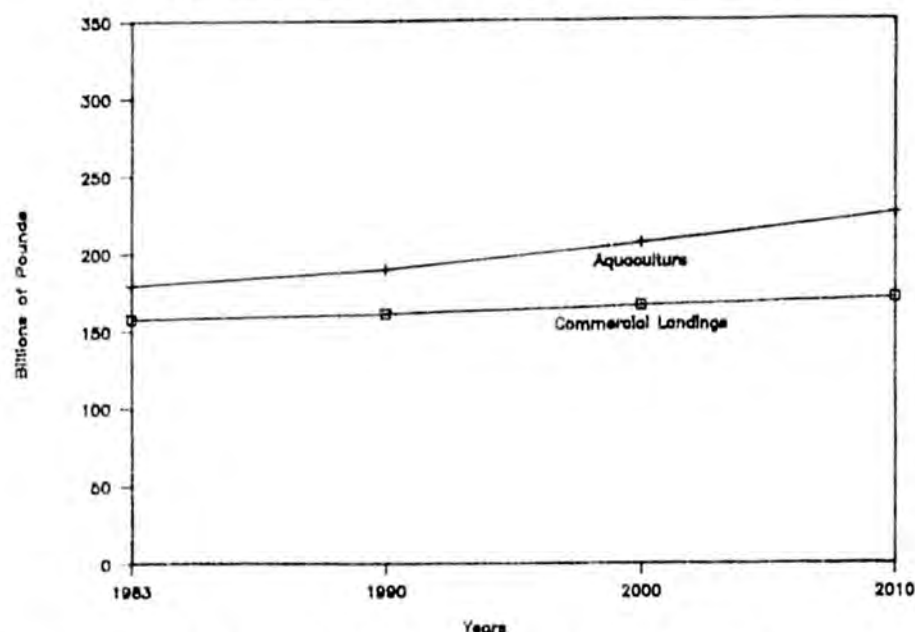
Many experts believe that we are in the early stages of a worldwide "blue revolution" in aquaculture similar to the "green revolution" of the 1960s and early 1970s, which transformed agriculture in developing countries through the use of improved seed strains, pesticides, fertilizers and modern farming techniques imported from the developed nations. Just as the "green revolution" turned food-importing countries, like India and Indonesia, from importers into net food exporters, the "blue revolution" will have profound social and economic consequences as the protein production potential of aquaculture is realized.

¹Memorandum from O.A. Mathisen, Dean, University of Alaska, Juneau, School of Fisheries and Science, to Donald O'Dowd, President, University of Alaska, regarding the Mariculture Advisory Committee, October 7, 1985.

²"The Outlook for Salmon and Shrimp Aquaculture Products in the World Markets," U.S. Department of Commerce, National Marine Fisheries Service, January 1985.

³"Future of Aquaculture: Profile of a Growth Industry," International Aquaculture Foundation, February 1985, p. 8.

FIGURE 1
World Production of Fish and Shellfish



Source: "Future of Aquaculture: Profile of a Growth Industry."

* * * *

Annual Per Capita Consumption

The current (1983) annual world per capita consumption of fish and shellfish is approximately 28.6 pounds (live weight equivalent). World population is expected to increase from 5 billion today to 6.1 billion by the year 2000.⁴ Anticipated annual world fisheries landings of 171 billion pounds by then would provide 28.5 pounds per person. However, annual world per capita consumption is growing and is expected to continue to grow to 34 pounds by the turn of the century. An additional 33 billion pounds per year will be required to meet anticipated demand, which provides an enormous opportunity for aquacultural development.⁵

⁴Statistical Abstract of the United States 1986, U.S. Department of Commerce, Bureau of the Census, December 1985, p. 838.

⁵"Future of Aquaculture: Profile of a Growth Industry," p. 8.

The U.S. seafood market is regarded by many in the business as the largest underdeveloped market in the world. Current U.S. annual per capita consumption of fish and shellfish grew 13 percent from 12.8 lbs. to 14.5 lbs. (edible meat) between 1980 and 1985 which translates into a 549 million pound annual increase.⁶ This trend is expected to continue into the future as American consumers become more knowledgeable about the health benefits of eating fish and shellfish and increasingly sophisticated about different species and various methods of preparation. One manifestation of this trend is the recent series of articles in the popular press extolling the virtues of omega-three fatty acids in seafood which have been directly linked to reductions in coronary heart disease, strokes and certain forms of cancer.⁷

Alaska's Place in the Blue Revolution

Alaska's competitive position in worldwide aquaculture development will depend on exploiting its comparative advantages in relation to the rest of the world. To this end, it is very important that we remain up to date on aquaculture development in other countries. A fundamental fact of free international trade in seafood products is the movement of capital and labor to their most productive uses. As this occurs, changes in the structure of the seafood industry are inevitable. New constituencies arise with different goals and objectives from the traditional fishing industry (i.e., a farmer's philosophical and political perspective is inherently different from a hunter's). Worldwide conditions of supply and demand combined with the economics of production and distribution will ultimately determine which species and markets are feasible for aquaculture products from Alaska.

Aquaculture development in Alaska has the economic advantage of a well-developed fisheries infrastructure and access at reasonable cost to rapidly growing domestic seafood markets. The classic economic development triad of cooperation between government, the university system and private industry (which has been one of the key characteristics of successful aquaculture programs in developed countries such as Japan and Norway) already exists in Alaska.

⁶"Fisheries of the United States 1985," U.S. Department of Commerce, National Marine Fisheries Service, Current Fishery Statistics No. 8380, April 1986, p. 79.

⁷William R. Heard and Thomas M. Kron, "Salmon Farming," Alaska Fish and Game, May-June 1986, p. 2.

Alaska's physical potential for aquaculture development is quite large, though narrowly defined. Alaska's major physical advantages are enormous natural salmon runs, clean nutrient-rich waters and vast areas of suitable habitat for development, which have heretofore been utilized with great success in the state's ocean-ranching and salmon-enhancement programs. For species other than salmon, cold water temperatures limit varieties that can be cultivated economically. Compared to salmon, all other potential aquaculture products which could be developed in the near (five-year) future are likely to be of relatively minor economic importance. In the intermediate (five to ten-year) future, the farming of oysters, mussels, scallops and sea vegetables could substantially diversify the state's aquaculture industry and become important to the economies of coastal communities.

The major economic disadvantage in Alaska is generally high operating costs. Alaska seafood products compete with close (or identical) substitutes from many other countries. Thus, we ignore developments in other countries that affect our markets at our own peril. The downside of the "green revolution" in world agriculture for farmers in developed countries has been that a diet of government subsidies led to massive overproduction, falling commodity prices and falling farm incomes. To be successful, State policies toward future aquaculture development should be oriented toward lowering producer costs to remain competitive in world markets.

While not necessarily a disadvantage, State policy is certainly a significant factor in the development of aquaculture in Alaska. Alaska is different from some of its competitors (e.g., Washington State, Norway or Japan) in that most of the potential aquaculture sites (at least the adjacent shoreline) in the state are owned by the government (State or federal) and not by private individuals and companies. The State controls tidelands from mean high water to three miles offshore. Thus, the terms that State government sets for leasing sites and the amount of red tape an operator must wade through to obtain control of the resource can be important factors in the economic viability of an aquaculture venture.

Other impediments to further aquaculture development are mainly political and legal. The state's fishing industry is generally receptive to developments such as oyster and mussel farms that do not threaten the status quo, but is more ambivalent toward competing enterprises such as the pen rearing of salmon. The Sheffield administration's policy generally reflected the attitude of the fishing industry and attempted to separate salmon farming (which it said should be studied further) from other forms of mariculture (which it flatly encouraged).

The Governor's Mariculture Advisory Committee policy statement recommended that "every effort be made to assure that the developing aquaculture industry: 1) be complementary to, and not in conflict with, the existing fishing

industry; 2) be economically viable and self-sustaining; 3) provide opportunities for family and other small-scale businesses; 4) provide an overall enhancement to the marketing image of all Alaska seafood products; and 5) give due consideration to wild stocks".⁸ These guidelines are ideals which have yet to be translated into firm development policies.

ALASKA'S UNIQUE SITUATION

In many ways, the circumstances surrounding aquaculture development in Alaska are unique. The fact that there is very little private ownership of the prime coastline for aquaculture sites (an important exception is coastline owned by Native corporations) has already been mentioned. A key prerequisite for investors in the economic development of any natural resource based industry is private ownership or long-term exclusive access to the resource (e.g., oil leases, timber sales, limited entry permits). Thus, the State and federal government are de facto partners with the aquaculture industry through their site-leasing arrangements and permit requirements.

Unlike most of the other countries that have turned to aquaculture for salmon production, Alaska's salmon stocks are not depleted. In fact, the commercial salmon harvest in Alaska has been at or near record levels for the past several years (Figure 2). Most experts agree that this is due, in order of importance, to a combination of favorable climatic conditions, improved management techniques and enhancement efforts.⁹ In 1985, Alaska produced 90 percent of U.S. commercial salmon landings and approximately 43 percent of the world salmon supply by volume (Figure 3).¹⁰

Much of the political ambivalence of the fishing industry in Alaska towards new forms of aquaculture (particularly salmon farming) and the xenophobic attitude towards developments in other countries can be explained by the states' colonial history of fisheries development.

hatred or distrust of foreigners

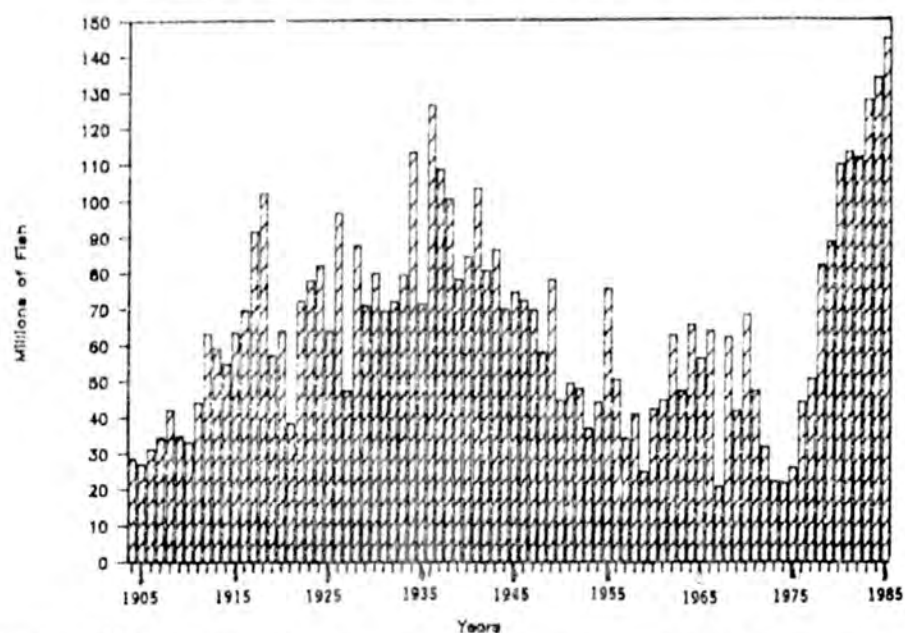
⁸Alaska Mariculture Advisory Committee, "A Philosophy for Aquaculture Development in Alaska," Memorandum to the Governor's Fisheries Mini-Cabinet, January 20, 1986.

⁹Lynn Hutton and Brad Pierce, "North Pacific Fisheries Delphi Project Final Report," Alaska Department of Commerce and Economic Development, September 1985, p. 15.

¹⁰Estimated from "Fisheries of the United States 1985" p. vii, and The University of Stirling (Scotland) Institute for Retail Studies market reports No. 2, p. 43.

FIGURE 2

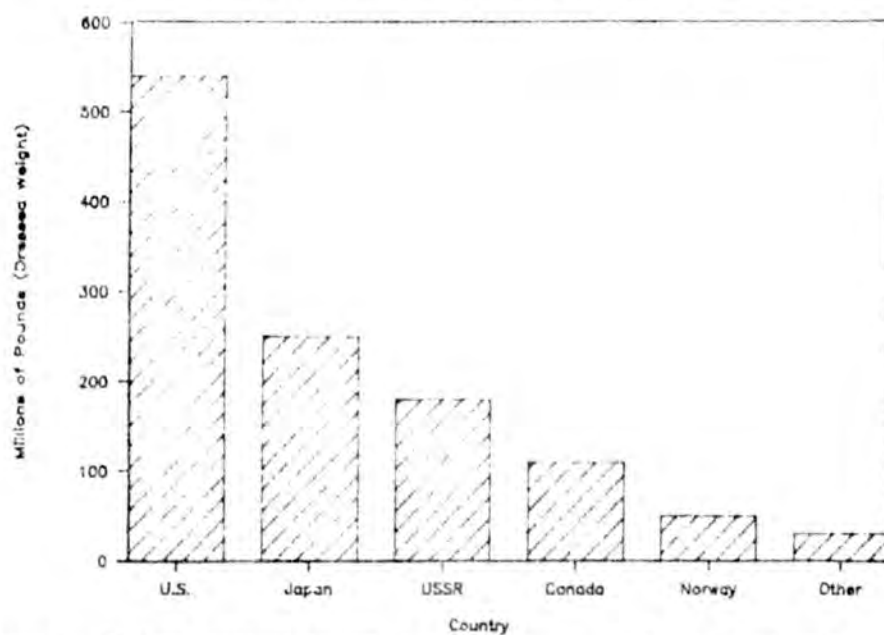
Alaska Commercial Salmon Catch 1904-85



Source: Alaska Commercial Salmon Catches 1878-1984, Alaska Department of Fish and Game, Division of Commercial Fisheries, February 1985.

FIGURE 3

World Salmon Production, 1984



Source: Seafood Business Report, Volume 4, Number 2, March/April 1985.

The Colonial Heritage of Alaska's Fishing Industry

Alaska suffers from a colonial heritage in its fisheries development that is very different from other states and countries that compete in the same world seafood markets. The headquarters, marketing and distribution segments of many seafood companies that operate in Alaska have traditionally been located outside of the state. Because of high costs and the remote location, seafood companies have historically invested as little as possible in Alaska, generally limiting themselves to the minimum required to extract resources in transportable form (i.e., canneries, cold storage facilities).

Foreign investors (particularly Japanese) own substantial equity and control much of the capital in the state's fishing industry.¹¹ In many cases, foreign interests have used their investment in the Alaska seafood industry merely as a means of securing an adequate source of raw product. Historically, much of the value added involved in secondary processing and producing finished consumer products has occurred in foreign marketing and distribution systems.

Like many developing nations (which the Alaska economy resembles) with colonial legacies, an attitude of resentment of residents against outside economic domination of the fishing industry persists.¹² One recent study by the Alaska Department of Labor showed that 65 percent of the 18,683 jobs and \$58.1 million in earnings in the food processing industry (which is almost entirely composed of seafood processing companies) during 1984 went to nonresidents who generally remained only for the duration of the fishing season and left to spend the bulk of their accumulated wages elsewhere.¹³

¹¹Franklin L. Orth, James R. Wilson, James A. Richardson, and Sandra M. Piddle, "Market Structure of the Alaska Seafood Processing Industry, Volume II, Finfish," University of Alaska Sea Grant Report 78-14, March 1981.

¹²George W. Rogers and Donna Mayer, "The Economic Importance of Commercial Fishing in the Southeastern Alaska Region," Institute of Social and Economic Research (ISER), University of Alaska, prepared for the National Marine Fisheries Service, February 1982, 2 Volumes.

¹³"Nonresidents Working in Alaska: A Special Study to Measure the Economic Impact of Nonresidents on Alaska's Economy During Calendar Year 1984," Department of Labor, January 17, 1986, p. 10.

In the harvesting sector of the state's salmon industry in 1984, 17,283 Alaska residents had gross earnings of \$219.1 million (\$12,700 per capita), while 5,858 nonresidents earned \$121.6 million (\$20,800 per capita).¹⁴ Slightly over 20 percent of permit holders in Alaska's limited fisheries are nonresidents.¹⁵ Thus, not only is much of the value added in the marketing and distribution sectors of the industry produced outside of the state, but also a major portion of the secondary effects of employment (i.e., processing employees and nonresident fishermen spending earnings on consumption and investment) escapes the local economy.

Alaska's Traditional Salmon-Fishing Industry

Fish politics are likely to be a major factor in future aquaculture development (particularly salmon farming) and deserve some further explanation. By its very nature, the commercial fishing industry tends to produce conservative individuals as skills are passed from generation to generation. Change tends to occur very slowly and painfully. Permit, vessel, gear and area restrictions (regulated inefficiencies) in Alaska's salmon fisheries are designed to limit harvester efficiency and maximize local employment.¹⁶ Within these constraints, fishermen tend to be fiercely independent and value their individualism highly. The commercial fishing industry has strong free market traditions but is heavily dependent on State management and financial involvement.

Historically, there has been an underlying adversarial labor versus management type of relationship between fishermen and processors, which dates back to early in the century when Seattle-based canneries held tight control over Alaska's salmon fisheries. With the implementation of limited entry in 1974, the balance of power shifted. Commercial fishermen gained exclusive harvest rights in the common property fishery and became less economically dependent on their relationship to specific processors. Fishermen's organizations also gained substantial political power. Throughout the history of Alaska's fishing industry, fishermen have tended to resist change until confronted by a biological crisis, as in the early 1970s when a series of severe winters and overharvesting by the Japanese (and other) high seas fleets devastated the state's salmon runs. Limited

¹⁴Source: Rich Focht, Commercial Fisheries Entry Commission, personal communication, August 1986.

¹⁵E. Dinneford and B. Hart, "Changes in the Distribution of Permit Ownership in Alaska's Limited Fisheries 1975-1985," Alaska Commercial Fisheries Entry Commission, CFEC Report Number 86-6, June 1986, p. vii.

¹⁶Crutchfield and Pontecorvo, The Pacific Salmon Fisheries: A Study of Irrational Conservation, Resources for the Future, Inc., 1969, p. 92.

entry and the current structure of the state's salmon hatchery system grew out of the resolution to this crisis, which involved an unprecedented cooperative agreement between fishermen, processors and State government (described in Chapter Two).

More recently, salmon fishermen's groups (which are organized by area and gear types) have tended to focus on narrow issues in the political arena. For the past several years, these groups have devoted inordinate amounts of time to internecine squabbles between gear types and with sportfishing interests over allocation decisions by the Board of Fish. Thus far, the reaction of fishermen's groups to aquaculture developments in other parts of the world, such as the rapid growth in production of pen-reared Atlantic salmon (and the possibility of salmon farming in Alaska) has been largely defensive. Fishermen do not currently perceive any personal economic incentive for themselves in salmon farming or other forms of mariculture. As one industry observer explained the attitudes of salmon fishermen toward farming, "There is a small and vocal group that have been affected in their traditional markets by salmon farming in other countries (i.e., trollers) and adamantly oppose pen rearing in Alaska. There is another segment who are interested in getting into salmon farming and are very well informed about it. The majority of salmon fishermen though are not directly affected and are probably interested in learning more about salmon farming but fairly uninformed about it."¹⁷

Processors, until very recently, have been preoccupied with financial problems caused by exchange rate fluctuations and unsold inventories of traditional salmon products. Some processors are interested in getting into salmon farming. Others see farmed fish as a competing source of supply, although several major processors in Alaska broker farmed fish from other countries. There are a number of conservatives among cannery owners and managers who feel that the economic benefits derived from Alaska's ocean ranching of salmon are vastly overrated. Some would like to scrap or scale back Alaska's hatchery programs.

Thus, the participants in Alaska's salmon-fishing industry do not speak with one voice about future aquaculture developments (particularly salmon farming). There is no biological crisis at hand, like that which precipitated limited entry, to solidify opinion. The economic impact of foreign aquaculture production on traditional markets has not affected all sectors of the industry equally. Rather, there is a more subtle erosion of Alaska's share of world salmon markets. Future aquaculture production in other countries will make global salmon markets (for both premium and low-value/high-volume species) increasingly competitive. It is ironic that, with such a huge share of the world's salmon production capacity and

¹⁷-----
Roger Painter, Alaska Mariculture Association, personal communication, November 1986.

larger runs than ever, Alaska does not actively dominate world salmon markets. Indeed, sockeye is the only salmon species where production from Alaska enjoys unchallenged dominance in world markets (and will probably continue to do so) and that is only because the state contains most of the world's prime natural habitat and other countries have so far been unable to produce significant volumes artificially due to disease problems. The fragmented structure and fractious nature of the fishing industry in the state has historically meant that fishermen and processors in Alaska are continually playing catch up with developments in other countries that affect their markets.

ROLE MODELS FOR AQUACULTURE DEVELOPMENT

In the following chapters, we attempt to take a broad view of aquaculture programs in other countries that affect markets for Alaska seafood products. We focus on the structure of extraordinarily successful aquaculture industries in Japan and Norway because they seem to be the most applicable to the situation in Alaska. After examining the industry structure in these countries, a few common sources of strength emerge. One is the close relationship between the government, private industry and the university system we have already mentioned. Other characteristics are the cooperative structure of producer organizations and vertical integration (backward and forward) of foreign seafood producers.

Typically in these model programs, there is close coordination between government, academic and private sector research efforts, with a very short distance between research and practical application. Some individuals are involved as both researchers and entrepreneurs. The opportunity for biologists and others to move easily between academia, government service and private industry appears to be very important in accelerating aquaculture development.

When the cooperative structure of producer organizations in the aquaculture industries of other countries is combined with vertical integration (from producer to distributor), it produces a self-sufficient economic entity with considerable market power. All fishermen and participants in the mariculture industry on the island of Hokkaido in Japan belong to the local cooperative. The same is true in Norway where all farmed salmon producers belong to a cooperative. The cooperative system derives its strength from the advantages of economies of scale and the incentive of individual members owning a share and having a personal economic stake in the quality and diversity of the products being produced.

In 1985, Alaska had 22 fishermen's cooperatives with an estimated 3,819 members,¹⁸ which is only a small fraction of the state's fishing industry. (Cooperatives in Alaska provide one or more of the following purposes: insurance, transportation, purchasing supplies, legislative lobbying, production, processing, marketing and/or collective bargaining.)

As we show in the following chapters, vertical integration of seafood companies is becoming increasingly important. It is likely that consolidation of the chain of distribution from producer to consumer will change the structure of many seafood companies in the future. Backward vertical integration refers to the development of the capability of a company to provide its own sources of supply (e.g. feed and smolts for salmon farms or spat for oyster farms). Forward vertical integration exists when companies acquire capability in the distribution chain of the goods they produce.¹⁹ Both of these forms of vertical integration tend to lower producer costs and increase revenues as they internalize the margins of middlemen. We give specific examples of vertically integrated cooperative associations in Japan, British Columbia and Norway in Chapters Two and Three.

The Role of State Government

The most pressing need for further aquaculture development in Alaska is to have a comprehensive State policy which addresses all forms of aquaculture. Since the State will be an active partner in future aquaculture development by virtue of its control over coastal waters, a game plan is needed to fit the different industry segments together. There are several legal bottlenecks (described in detail in the following chapters) in the State statutes that need to be dealt with by the legislature. The present legal situation, as interpreted by the Attorney General's Office, is an impediment to all new forms of aquaculture development. A nonindigenous species, Pacific oysters, is allowed to be commercially cultivated in the marine waters of Alaska, while native species such as salmon and scallops are illegal to farm for commercial sale.

In other states and countries, aquaculture is usually administered under either the category of fisheries or agriculture. Newer forms of mariculture contemplated for Alaska do not neatly fit into the existing executive branch structure. Some mariculture proponents have called for a "lead agency" to coordinate the development of State policy with other State agencies and interested parties. The Department of Commerce and Economic Development (DCED) has been suggested as an appropriate lead

¹⁸"Fisheries of the United States, 1985," p. 88.

¹⁹"Market Structure of the Alaska Seafood Processing Industry," p. 47.

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agency for policy development since it contains the Office of Commercial Fisheries Development, Alaska Seafood Marketing Institute and administers the Fisheries Enhancement Loan Program. Developing a proper organizational structure for the aquaculture industry is an area where legislative leadership would be useful.

The extent of State financial involvement in diversifying the aquaculture industry needs to be determined. Several aspiring salmon farmers would like to be able to purchase smolts and receive disease control and genetic development support from the State. Shellfish growers would like paralytic shellfish poison testing labs located within reasonable distance from their operations and in-state hatchery facilities. Many potential mariculture operators would like some form of State loan program, similar to those currently enjoyed by fishermen and private nonprofit hatchery operators.

Other mariculture proponents think that the State should simply stay out of the way of development. They claim that further diversification of aquaculture in Alaska will occur spontaneously if the legislature simply removes the legal bottlenecks mentioned above and develops an adequate permitting system. The newer forms of mariculture discussed in Chapters Three and Four of this paper are ultimately bankable enterprises and will probably attract investors without a financial commitment from the government. The character of the aquaculture industry (the mix of corporate and family-type operations) and the pace of development will, to a certain extent, be determined by the level of State financial support. We identify specific policy considerations and discuss the general propositions stated above for each form of aquaculture in the state (existing or contemplated) in the following chapters.

CHAPTER TWO

OCEAN RANCHING

The ocean ranching of salmon, i.e., the raising of juveniles in hatcheries which are released to go to sea and return as adult fish, is by far the most important aquacultural activity in Alaska. Ocean ranching augments Alaska's comparative advantage of enormous natural salmon runs and smoothes cyclical fluctuations in the supply of the resource. No other form of aquaculture in the foreseeable future will even come close to being as important to the State economy as ocean ranching. Additionally, the State's system of public and private salmon hatcheries is the key to further diversification of salmon aquaculture in Alaska.

In this chapter, we discuss the relationship between Alaska's ocean-ranching program and ocean ranching in other countries around the world. The issues surrounding salmon hatchery production in Alaska are discussed in detail and related to world markets for high-volume salmon species. The relationship between Alaska's salmon hatcheries and a possible salmon-farming industry is analyzed.

HATCHERY RELEASES IN THE NORTH PACIFIC

The major salmon producers in the North Pacific--Japan, the Soviet Union, British Columbia, and the Pacific Coast states of Washington, Oregon and Alaska--all have salmon-ranching programs. It is conceivable that, if all of these programs reach their production goals (which is unlikely given present funding levels), as many as 11 billion hatchery-produced juvenile salmon could be released into the ocean feeding grounds by the end of the century. Hatchery releases of this magnitude could bring Pacific Rim salmon production back to peak 1930s levels.²⁰ Salmon hatcheries are about eight times more efficient at converting eggs into fish than the natural environment.²¹ No one really understands the biological factors (i.e., the nature of mortality processes, interaction of natural and hatchery stocks, environmental factors, species and timing of releases) which determine the salmon-carrying capacity of North Pacific, but many experts feel that eventually some sort of political accommodation will have to be reached among the various countries involved over rights to ocean feeding grounds outside their respective 200-mile Exclusive Economic Zones (EEZ).

²⁰-----
"North Pacific Fisheries Delphi Project Final Report," p. 22.

²¹Jeffrey A. Hansen, ed., "FRED 1985 Annual Report to the Alaska State Legislature," Alaska Department of Fish and Game, FRED Report 59, January 1986.

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Some experts feel that a future treaty among North Pacific salmon producers may be necessary to establish production levels on some sort of grandfather basis, in which case, the participants out there earliest with the most releases would be the best off. Currently, the U.S., Canada and the Soviet Union are exerting considerable diplomatic and economic pressure on Japan and Taiwan to curtail their high seas salmon harvests. It is likely that these types of disputes will continue and possibly intensify in the future as each country seeks to maximize the economic potential of its salmon-ranching investment. The market implications of these programs point to a long-term increase in the world supply of the low-value/high-volume species of Pacific salmon, specifically pinks and chums, which are the cheapest species to raise.

A BRIEF OVERVIEW OF SALMON-RANCHING PROGRAMS IN OTHER STATES AND COUNTRIES

Japan

Japan is currently the world's largest single producer of hatchery-raised salmon.²² It is estimated that between 70 and 80 percent of all fry descending Japanese rivers are hatchery-raised. Although the quality of the water in Japanese rivers and streams is quite high, nearly all of the natural spawning areas have been rendered unsuitable through habitat degradation of one form or another. Poaching of fish in the rivers is also a serious problem, so most returning salmon are not allowed to spawn naturally. (Limited sportfishing for salmon is allowed only in saltwater and is not nearly the popular leisure pursuit in Japan that it is in North America.) Returning adults are collected in traps as they enter the rivers, where the eggs are taken and transported to hatcheries. Fry are then released where needed.

The 1985 Anadromous Salmon Artificial Incubation and Release Plan, published by the Japanese Fishery Agency, calls for release of 1.17 billion fry (1.04 billion chum, 114 million pinks, 13 million cherry salmon and 150 thousand sockeye), which is slightly lower (two percent) than the 1984

²²Jeff Hansen, "A Look at International Aquaculture: How Many Fish Can the Oceans Hold?" Alaska Fish Tails and Game Trails, Spring 1982, p. 36.

level of releases.²³ There is some evidence that Japan has nearly maximized its hatchery production potential.

Since the late 1960s, the Japanese high seas catch of salmon has declined from approximately 83 million fish to about 20 million, due mainly to the imposition of the U.S. 200-mile limit and other international agreements that restrict the high seas salmon harvest. During the same period, the Japanese coastal catch, consisting mainly of returning hatchery-raised adult chum salmon, increased from 12.8 percent of the total salmon catch in 1965 to 67.3 percent in 1979. Thus, the cumulative increase in hatchery production has more than offset the loss of the high seas fishery. The 1984 return of chum salmon (which is the predominant species and the only one for which we have data) to the Japanese coastal salmon fishery was 37.8 million fish.

Commercial salmon fishermen in Japan are highly organized and work very closely with prefectural governments as well as federal and municipal officials to manage the salmon harvest.²⁴ About 90 percent of the chum salmon harvest in coastal waters is taken with fish traps, though gillnets and longlines are also used. Fishermen in a given area belong to the local fishermen's cooperative and sell their catch through the cooperative. In 1983, there were 301 salmon hatcheries in Japan. Of these, 37 were operated by the national government, 15 by prefectural governments and the remainder by fishermen's cooperatives or local governments.

The Hokkaido Fishermen's Cooperative

The Hokkaido Salmon Propagation Association offers a concrete example of how the Japanese ocean-ranching system works. The association was established in 1976 in response to public concern over the level of government funding of hatchery operations (approximately \$10 million in 1983) on the island. On Hokkaido, major decisions concerning the salmon fisheries are made every five years, while adjustments concerning the opening and closing dates for the season at each of the 24 management areas (covering 790 salmon trap and gillnet permits) are made annually. Within their association, salmon fishermen work closely with hatchery staff. The fishermen bear most of the costs and contribute large amounts of free labor to adult

²³Kay Hayashi, Alaska State Office, Tokyo, Japan, Memorandum dated July 9, 1986 to Greg Baker, Department of Commerce and Economic Development, Office of Commercial Fisheries Development, containing a translation of a Fisheries News release.

²⁴Thomas M. Kron, "Japan's Salmon Culture Program and Coastal Salmon Fisheries," Alaska Department of Fish and Game, FRED Report Number 50, September 1985, p. 7.

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capture and spawning operations (e.g. weir operations and egg stripping). To help pay for operating costs, the association is allowed to sell a portion of the male fish (50 to 60 percent) at the time of capture in the river, and also the spawned-out salmon carcasses. There is a two percent tax on the fishery to cover the remainder of the association's costs.

The Hokkaido example is a model of how fishermen's organizations can cope with decreases in government support for aquaculture. Within the fishermen's association, there is a great diversity of effort. In addition to ranching chum salmon, individual operators may focus on raising and harvesting scallops, abalone, oysters and various species of seaweed or pen rearing cherry and coho salmon (coho eggs are generally purchased from Washington and Oregon).²⁵

The cooperation of individuals within the group is the dominant characteristic and a source of great economic strength and adaptability in the Japanese fishermen's cooperative system. The combination of vertical integration from the hatchery through harvesting and marketing of adult fish, substantial amounts of free labor from association members, and use of the most efficient available harvesting methods minimizes operating costs and maximizes economic return to members of the cooperative. The Japanese have the most cost-effective ocean-ranching programs in the world and the great diversity of aquaculture products they produce through their cooperative system is a model for other nations. Benefit/cost ratios for individual chum salmon hatchery programs on Hokkaido are estimated to range between 16:1 and 33:1.

Soviet Union

The Soviet Union has a natural spawning potential for Pacific salmon that is very similar to Alaska, i.e., most of their salmon-rearing and spawning habitat has not been altered or destroyed and hatchery production is designed to augment rather than replace natural production. One significant difference is the relative lack of sockeye habitat (stream systems containing lakes) in the U.S.S.R. Information on the number and species of hatchery releases is sketchy and difficult to verify, but it is estimated that one quarter of the Soviet salmon harvest (40 to 70 million fish,

²⁵ Cherry salmon are an Asian species, similar to coho, which is native to Japan and is produced (in limited quantity) entirely for the domestic Japanese market.

mainly pink salmon) comes from returning hatchery adults.^{26, 27} In 1980, the Soviets released 1.14 billion juvenile salmon from 30 hatcheries and planned to build 52 more hatcheries and release 4.97 billion fry by 2000.

Another, more recent source has quoted Soviet Fisheries Minister Vladimir Kementsev as claiming the number of Pacific salmon released in 1985 at "up to 7 billion."²⁸ (We have no independent confirmation of this figure and suspect that this claim was probably either misquoted or a gross exaggeration.) Thus, it is difficult to determine the actual magnitude of the Soviet ocean-ranching program. We do know that their most productive hatcheries are on Sakhalin Island, which they took over from the Japanese (along with 12 operating hatchery facilities) after World War II and have since rebuilt and expanded. Under a recent (1983) agreement, receipts from a tax on the Japanese high seas gillnet fishery in Soviet waters (\$17.1 million in 1983) have been used to purchase materials and hatchery technology from the Japanese. All of the available information we have gathered on the Soviet ocean-ranching programs points to a very large-scale and long-term commitment to hatchery production, particularly of pink and chum salmon. Exports of salmon products currently are an important source of foreign exchange for the Soviets and are likely to become even more important in the future.

British Columbia

The British Columbia Salmonid Enhancement Program (SEP) of the Department of Fisheries and Oceans (DFO) is the Canadian version of the public hatchery program in Alaska and uses the same diversified approach (hatcheries, spawning channels, incubation boxes and lake fertilization techniques) to produce salmon for sport and commercial fisheries. The SEP is currently in the first phase of a project whose long-term goal is to produce an additional 27 million adult fish. A summary of 1985 SEP fish production and a forecast of the future catch from SEP projects at design capacity is given on the next page.

²⁶Jeff Hansen, "A Look at International Aquaculture--How Many Fish Can the Oceans Hold?", p. 13.

²⁷Richard Bard, "Salmon, An Ever Changing Supply," Seafood Business Report, March/April 1985, p. 45.

²⁸"Russian Show Focus on Fish Breeding," Fish Farming International, Vol. 13, No. 6, p. 16.

Table 1

British Columbia Hatchery Production Statistics

Species	Summary of 1985 SEP Fish Production			Phase I Forecast
	Juveniles Released	Expected Adult Production	Expected Catch (number of fish)	Expected Catch at Design Capacity
Sockeye	253,538,358	3,584,125	1,944,317	2,644,786
Chum	164,466,012	2,298,653	1,209,414	1,337,226
Pink	6,146,989	49,918	29,940	98,241
Coho	25,406,466	1,480,479	965,767	1,581,901
Chinook	34,629,812	488,126	292,048	451,862
Steelhead	2,020,396	45,526	27,684	28,942
Cutthroat	145,447	12,685	8,497	11,745
Total	486,353,480	7,959,512	4,477,667	5,318,493

*Preliminary data as of September 1986.

Sources: Carol Cross, Assessment Biologist, SEP, "1985 SEP Fisheries Statistics" raw data.

* * * * *

In addition to supplying juvenile salmonids for sport and commercial fisheries, the SEP sold about 14 million surplus eggs (three million chinook, nine to ten million coho and 1.5 million steelhead) to private salmon farms in 1986.²⁹ Demand for 1987 is expected to be 29 million eggs (15 million coho and 14 million chinook). The Salmonid Enhancement Program will probably be able to supply only about four million chinook eggs due to treaty obligations. As we discuss in Chapter Three, the British Columbia salmon-farming industry has undergone explosive development in the past two years, which has caused a critical shortage of chinook

²⁹Under the terms of the U.S.-Canada salmon treaty concluded in 1984, harvest quotas for chinook salmon were set which were based on each country's natural and hatchery-raised production. Each country is obligated to produce at least as many hatchery-raised adult chinook as it produced before the treaty was signed. Surplus eggs, then, are defined as numbers estimated to be in excess of the amount required to meet this minimum hatchery production level. The current SEP strategy is to hold chinook egg production for hatcheries at the minimum treaty level.

and coho eggs and/or smolts. British Columbia has no privately run hatcheries (comparable to the private nonprofit system in Alaska) which produce juvenile salmon for the common property sport and commercial fisheries. Because there are currently only five or six private fish farms in the province with adult salmon and trout capable of producing eggs (which are currently being sold to salmon farmers at exorbitant prices), the SEP has been under intense pressure from salmon farmers to either sell them eggs or smolts or allow imports from other countries (including imports of Atlantic salmon).

Conflicts between commercial and sport fishermen over the common property fishery catch are similar to those that exist in Alaska. The situation is exacerbated by the fact that the SEP is almost entirely funded by appropriations from the provincial government. The only revenues which the SEP generates (aside from egg sales mentioned above) come from the sale of spawned-out carcasses and surplus jacks recovered at hatchery sites, which go into the government's general fund. The current funding level of the SEP (\$33.4 million Canadian) is about 70 to 80 percent of what is required to meet the enhancement goals (portrayed in Table 1). This incomplete level of funding has persuaded program managers to change the species composition of its enhancement efforts toward fewer pink and greater chum and sockeye releases. The British Columbia Department of Fisheries and Oceans is currently studying the possibility of imposing an assessment or user fee on the commercial salmon catch to help fund enhancement efforts. In its present form and at the current funding level, the overall benefit/cost ratio of the SEP (average for all projects) is estimated to be between 1.31 and 1.67 to 1.³⁰

Washington State

Washington State hatchery production of juvenile salmon (365 million total releases in 1985) is on the same order of magnitude as British Columbia. Due to budget reductions, however, Washington hatchery releases are expected to decline slightly into the indefinite future, which will lower the Department of Fisheries annual target level of 4.8 million pounds of adult returns. Washington State salmon hatchery releases for 1985 by species are listed below:³¹

Chinook	147,908,180
Sockeye and Steelhead	2,636,291
Coho	108,768,864
Chum	105,849,424
Pink	210,000
Total	365,372,759

³⁰Carol Cross, personal communication, August 1986.

³¹Source: Bob Foster, Fish Biologist, Washington Department of Fisheries, Salmon Culture Division, August 1986.

OCEAN RANCHING

Washington State hatcheries are funded primarily through general fund appropriations. Hatchery construction debt service is paid through fees charged for commercial salmon fishing licenses and a \$3 salmon punchcard required of sportfishermen. Salmon rehabilitation programs in the Pacific Northwest are mainly aimed at mitigating the losses of natural spawning and rearing habitat destroyed by the construction of hydroelectric dams. There are approximately 150 hatchery facilities in Washington state, of which 46 are state-operated, 50 are run by cooperative groups (including educational facilities and fishermen's cooperatives), 16 are run by Indian tribes and 9 are run directly by the federal government. Seven hatcheries on the Columbia River are federally funded but run by the state, while six others are financed and run by public utilities. The remainder are private facilities which mainly produce eggs and/or smolts for their own salmon-farming operations, or for sale to other salmon farms and/or for export. The state also sells surplus eggs to other countries (e.g. Japan, Chile, New Zealand) and other states, but only after all in-state demands have been met.

Washington State law requires salmon rehabilitation facilities to be built, regardless of cost, on hydroelectric projects. Therefore, benefit/cost ratios for individual hatcheries can vary widely from about 14:1 to less than 1:1, though the average for all facilities is estimated at 5-6:1.

Oregon

Oregon has a state and federally funded hatchery program similar to Washington's. Additionally, there are three major private ocean-ranching companies in Oregon, which collectively released approximately 13 million coho, three million chinook, two million pinks and two million chums in 1985. Releases from state, federal and private utility hatcheries over the next two years (Oregon has a biennial budget process) will total 34.7 million coho, 95.3 million chinook and 12.2 million steelhead.³² Oregon's state-run hatchery programs are funded via general appropriations, sport and commercial license fees, and poundage fees on the commercial catch. Additional hatchery facilities (federally funded) to be constructed over the next two years will increase production by five million smolt. So far, harvests by the private ocean-ranching companies (after passing through the common property commercial and sport fisheries) have been highly variable and insufficient to generate sustained profits. Thus, the future of these operations is unclear. Potentially, private ocean-ranching corporations could release another 10 to 15 million smolts annually over the next several years.

³²Source: Jerry Baur, Program Director for Propagation, Oregon Department of Fish and Wildlife, August 1986.

The Oregon Department of Fish and Wildlife will be making an effort to evaluate the hatchery contribution to the state's salmon fisheries during the next biennium and thus does not currently have benefit/cost figures for its hatchery programs.

OCEAN RANCHING IN ALASKA

The cornerstone of Alaska's aquaculture industry is the State's system of public [Fisheries Rehabilitation and Enhancement Division (FRED)] and private nonprofit (PNP) salmon hatcheries which are designed to augment the state's enormous natural runs. As enumerated in Chapter One, by almost any economic measure (i.e., employment, income, total economic activity), aquaculture is probably the best renewable resource investment the State has made with its oil wealth. Figure 4 is a map showing the location and permitted capacity of Alaska's 20 FRED and 29 PNP salmon hatcheries (a location key follows the map).³³ In 1985, 987 million eggs were taken for incubation in the State's hatcheries and 653 million juvenile salmon were released. About 17.1 million adult salmon returned to the state in 1985 from hatchery releases in previous years. Table 2 provides a breakdown of eggs taken, juveniles released and adult returns for 1985 by species and hatchery operator. The statewide commercial salmon catch in 1985 (natural production plus hatchery returns) was a record 144.6 million fish.³⁴ The goal of the State ocean-ranching program is to produce 25 million adult salmon for harvest. Considering that this goal was set in 1975 when the two previous years had seen total statewide salmon harvests below 25 million, remarkable progress has been made (Figure 2).³⁵ The phenomenal growth in production from Alaska's hatcheries is portrayed in Table 3.

Following the figure and tables, we present a brief overview of the current status of the public and private hatchery systems in Alaska.

³³Of 29 PNP hatcheries that have applied to Alaska Department of Fish and Game, FRED, for permits to operate, seventeen are operational, five are at the preliminary application stage (four inactive and one--the Virginia Lake hatchery--with review suspended), six are classified as not operational and one--the Gastineau Channel site--listed as applied.

³⁴Source: Alaska Department of Fish and Game, Computer Services Division.

³⁵"FRED 1985 Annual Report to the Alaska State Legislature," Preface.

FIGURE 4

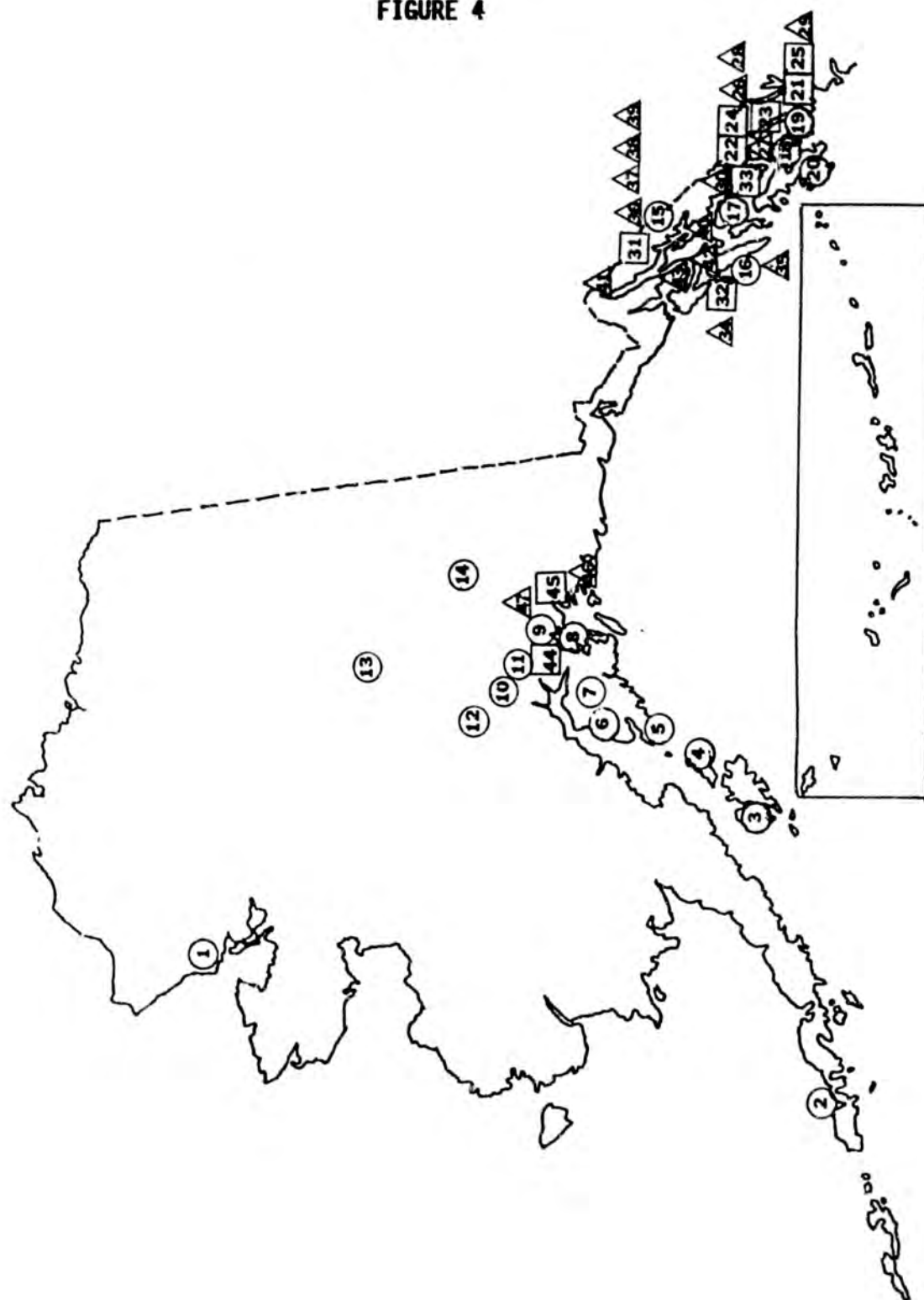


FIGURE 4 KEY
LOCATION AND DESIGN CAPACITY OF ALASKA DEPARTMENT
OF FISH & GAME, FRED, HATCHERIES

<u>Hatchery</u>	<u>Status</u>	<u>Location</u>	<u>Actual Egg Capacity (In Millions)</u>
(1) Sikusuiq	Operational	Noatak River	2.0 Chum
(2) Russell Creek	Operational	Cold Bay	5.0 Chum
(3) Karluk Lake	Operational	Kodiak Island	25.0 Sockeye
(4) Kitot Bay	Operational	Afognak Island	100.0 Pink/Chum
(5) Tutka Bay	Operational	Homer	30.0 Pink/Chum
(6) Crooked Creek	Operational	Kasilof	20.0 Sockeye
(7) Trail Lakes	Operational	Moose Pass	30.0 Sockeye--6.0 Coho--4.0 Chinook
(8) Main Bay	Operational	Prince William Sound	125.0 Pink/Chum
(9) Cannery Creek	Operational	Prince William Sound	100.0 Pink/Chum
(10) Elmendorf	Operational	Anchorage	1.0 Coho--1.6 Chinook
(11) Fort Richardson	Operational	Anchorage	3.2 Coho--1.6 Chinook--2.7 Rainbow
(12) Big Lake	Operational	Wasilla	20.0 Sockeye--10.0 Coho
(13) Clear	Operational	Anderson	.2 Coho--.2 Chinook-- .5 Chum--1.6 Grayling/Sheefish

FIGURE 4 KEY (Continued)
 LOCATION AND DESIGN CAPACITY OF ALASKA DEPARTMENT
 OF FISH & GAME, FRED, HATCHERIES

<u>Hatchery</u>	<u>Status</u>	<u>Location</u>	<u>Actual Egg Capacity (In Millions)</u>
(14) Gulkana River	Operational	Paxson	30.0 Sockeye
(15) Snettisham	Operational	Juneau	71.5 Chum--1.5 Coho--3.5 Chinook
(16) Hidden Falls	Operational	Baranof Island	61.0 Chum--.5 Chinook
(17) Crystal Lake	Operational	Petersburg	.3 Chum--1.5 Coho--4.2 Chinook-- .1 Steelhead
(18) Deer Mountain	Operational	Ketchikan	.9 Coho/Chinook
(19) Beaver Falls	Operational	Ketchikan	3.0 Sockeye
(20) Klawock	Operational	Prince of Wales Island	30.0 Chum--1.5 Coho--3.5 Chinook

FIGURE 4 KEY (Continued)
LOCATION AND PERMITTED CAPACITY
OF PNP HATCHERIES

<u>Region/Company</u>	<u>Hatchery</u>	<u>Status</u>	<u>Location</u>	<u>Permitted Egg Capacity (In Millions)</u>
Southern Southeast Regional Aquaculture Association (SSRAA)	[21] Whitman Lake	Operational	Ketchikan	31.8 Chum-- 3.4 Coho-- 1.5 Chinook--2.5 Sockeye
	[22] Tyee Lake	Preliminary Appli- cation (Inactive)	Wrangell	40.0 Pink/Chum--4.0 Coho-- 2.0 Chinook (Requested at start up)
	[23] Neets Bay	Operational	Revill- agigedo Island	60.0 Chum--5.0 Coho-- 4.0 Chinook
	[24] Virginia Lake	Preliminary Appli- cation-Review Suspended	Wrangell	40.0 Chum--4.0 Coho-- 4.0 Sockeye (Requested at start up)
	[25] Beaver Falls	Operational	Ketchikan	.3 Sockeye
Alaskan Aquaculture, Inc.	[26] Burnett Inlet	Operational	Wrangell	10.0 Pink--20.0 Chum-- 0.25 Coho--0.75 Chinook
Meyers Chuck Aqua- culture Association	[27] Meyers Creek	Operational	Meyers Chuck	5.0 Pink--1.0 Coho--5.0 Chum
Aquaculture, Inc.	[28] Crittenden Creek	Not Operational	Wrangell	12.0 Chum--3.0 Pink
Gro-Fish, Inc.	[29] Santa Ana Creek	Not Operational	Ernest Sound	3.0 Pink--10.0 Chum

FIGURE 4 KEY (Continued)
LOCATION AND PERMITTED CAPACITY
OF PNP HATCHERIES

<u>Region/Company</u>	<u>Hatchery</u>	<u>Status</u>	<u>Location</u>	<u>Permitted Egg Capacity (In Millions)</u>
Twin Creek Salmon Ranch Inc.	[30] Twin Creek	Preliminary Appli- cation (Inactive)	Petersburg	0.5 Pink (Request at start up)
Northern Southeast Regional Aquaculture Association (NSRAA)	[31] Salmon Creek	Not Operational	Juneau	30.0 Pink/Chum--0.8 Coho
	[32] Medvejie Creek	Operational	Sitka	28.0 Chum--3.3 Coho-- 0.3 Chinook--0.1 Pink
	[33] Port Camden	Operational	Kuiu Island	10.0 Chum
Sheldon Jackson College Aquaculture Program	[34] Indian River	Operational	Sitka	16.0 Pink/Chum--0.15 Coho-- 0.3 Chinook-- 0.1 Pink
Tlingit & Haida Fisheries Develop- ment Corporation	[35] Sandy Bay	Not Operational	Baranof Island	25.0 Pink/Chum
Douglas Island Pink & Chum, Inc.	[36] Kowee Creek	Operational	Juneau	10.0 Pink/Chum
	[37] Sheep Creek	Operational	Juneau	40.0 Pink/Chum--0.5 Coho
	[38] Fish Creek	Preliminary Appli- cation (Inactive)	Juneau	60.0 Pink--10.0 Chum--trout undetermined (Requested at start up)
	[39] Gastineau Channel	Application	Juneau	100.0 Pink--111.0 Chum-- 1.0 Coho-- 0.2 Chinook
Kake Nonprofit Fisheries Corporation	[40] Gunnuk Creek	Operational	Kake	16.0 Pink/Chum

FIGURE 4 KEY (Continued)
LOCATION AND PERMITTED CAPACITY
OF PNP HATCHERIES

<u>Region/Company</u>	<u>Hatchery</u>	<u>Status</u>	<u>Location</u>	<u>Permitted Egg Capacity (In Millions)</u>
Burro Creek Farms	[41] Burro Creek	Operational	Skagway	10.0 Pink/Chum 0.015 Coho
Armstrong-Keta, Inc.	[42] Port Armstrong	Operational	Baranof Is.	16.0 Pink--4.0 Chum 0.8 Chinook
Angoon Aquaculture Association, Inc.	[43] Favorite Bay	Not Operational	Angoon	7.5 Pink--20 Chum 1.5 Coho
Prince William Sound Aquaculture Corp. (PWSAC)	[44] Port San Juan	Operational	Evans Is.	150.0 Pink--13.0 Chum
	[45] Esther Lake	Operational	Esther Is.	211.0 Pink--111.0 Chum 1.0 Chinook--1.0 Coho 31.0 Sockeye
Nerka, Inc.	[46] Perry Island	Not Operational	Prince William Sound	10.0 Pink--10.0 Chum
Valdez Fisheries Development Association	[47] Solomon Gulch	Operational	Valdez	136.0 Pink--18.0 Chum 1.0 Coho--0.05 Chinook
McClure Bay Hatchery Inc.	[48] Port Nellie Juan	Preliminary Appli- cation (inactive)	McClure Bay	30 Pink--undetermined Chum
Cook Inlet Aquaculture Association (CIAA)	[49] Eklutna Hydro Project	Operational	Matanuska Valley	20.0 Pink/Chum--1.1 Coho 0.1 Chinook

Source: Private Nonprofit Hatchery Program Status Sheet, July 1986.

Prepared by the House Research Agency, December 1986.

TABLE 2

Number of Salmonid Eggs taken in Alaska by Species & Hatchery Operators (1985)

	<u>SSRA</u>	<u>NSRRA</u>	<u>PWSAC</u>	<u>CIAA</u>	<u>NON-ASSOC</u>	<u>FRED</u>	<u>ALASKA TOTAL</u>
Pink			162,750,000	80,000	177,080,000	264,700,000	604,610,000
Chum	45,330,000	26,800,000	19,520,000	2,070,000	25,730,000	112,292,600	231,742,600
Sockeye	310,000					108,070,000	108,380,000
Coho	3,480,000	50,000		190,000	380,000	13,234,000	17,334,000
Chinook	5,840,000	290,000			50,000	11,862,000	18,042,000
Other						7,180,000	7,180,000

Releases of Juvenile Salmonids in Alaska by Species & Hatchery Operators (1985)

Pink			103,530,000	280,000	95,680,000	164,400,000	363,890,000
Chum	55,130,000	6,230,000	23,410,000		13,110,000	102,881,100	200,761,100
Sockeye						71,019,000	71,019,000
Coho	3,010,000	1,080,000		40,000	90,000	9,620,100	13,840,100
Chinook	700,000	20,000				3,220,100	3,940,100
Other						3,267,000	3,267,000

Estimated Number of Adult Salmon Returns in Alaska by Species & Hatchery Operators (1985)

Pink		60,000	5,030,600		2,314,200	7,312,900	14,717,700
Chum	435,780	45,980	31,940	2,880	8,510	863,860	1,388,950
Sockeye						765,000	765,000
Coho	143,900	20,670		610	3,250	130,960	299,390
Chinook	7,500	690				20,450	28,640

SOURCE: Compiled by Jeff Hansen, Biologist--FRED Division, Department of Fish and Game, August 1986.

TABLE 3

Alaska's Ocean Ranching Program 1976-85

FRED Hatcheries

Year	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>
Eggs Taken (millions)	55.0	70.0	95.0	88.3	169.3	225.3	287.7	401.2	441.2	517.3
Fry Released (millions)	7.0	27.0	43.0	55.0	53.2	131.6	197.4	258.7	305.3	354.3
Adult Returns (thousands)	30.0	35.0	275.0	688.0	880.0	2,003.0	1,593.0	2,279.0	3,163.7	9,093.1

PNP Hatcheries

Year	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>
Eggs Taken (millions)	16.6	37.0	37.3	54.3	125.7	223.6	234.4	261.3	372.9	470.0
Fry Released (millions)	3.7	12.4	26.8	29.1	35.6	101.6	127.0	170.4	217.7	302.3
Adult Returns (thousands)		160.1	161.0	356.5	1,506.5	2,563.9	5,340.7	4,286.0	4,764.1	8,106.5

Source: Jeff Hansen, Alaska Department of Fish and Game, FRED.

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FRED Hatcheries

The Alaska Department of Fish and Game, Fisheries Rehabilitation and Enhancement Division (FRED) was established by the State Legislature in 1971 to encourage the use of hatcheries and other enhancement techniques to return the state's then depressed salmon fisheries to abundance.

FRED was charged with planning and implementing a program to ensure the perpetual and increasing production and use of the state's fishery resources. Bond issues totaling \$56.17 million were authorized by the 1976 and 1978 Legislatures (and overwhelmingly endorsed by voters) to fund the construction and operational costs of hatchery production and other enhancement developments in each region of the state.³⁶ The division currently operates 20 hatcheries which produce salmon and trout for subsistence, commercial and sport fisheries (see Table 3). An additional 23 fish passes (several maintained cooperatively with the U.S. Forest Service) provide access to spawning and rearing habitat that would otherwise be unavailable to salmon stocks. Other enhancement operations include lake fertilization, habitat improvement and fish stock introduction to provide increased freshwater survival and new salmon production opportunities.

FRED administers the Private Nonprofit (PNP) Hatchery Program and coordinates the development of regional aquaculture associations, approves annual operations management plans for all salmon hatcheries, and reviews PNP hatchery applications and the permitting process (which includes hatchery and fish transporting permits). FRED operates four biological laboratories--Fish Pathology, Genetics, Limnology, and Tag Recovery facilities--which provide information and support for FRED and PNP hatchery programs. In addition, FRED provides engineering service support to the department (including field facilities) and coordination with consultants, contractors and landowners.

The FY 87 FRED budget (Governor's revised plus all other funding sources) is \$14.7 million, down 6.4 percent from FY 86 (\$15.69 million). Of the \$56.17 million in bond issues for FRED enhancement projects cited above, \$50.3 million has been spent on hatcheries around the state, while the remainder has been used for other purposes (e.g., boats, fish passes, etc).³⁷

³⁶Jeff Hansen and Jerry Madden, "Hatcheries in Alaska," Alaska Fish and Game, May/June 1986, p. 7.

³⁷Jeff Hansen, Biologist, Alaska Department of Fish & Game, FRED, personal communication, November 1986.

Private Nonprofit Hatcheries

The Private Nonprofit (PNP) Hatchery Program was created by the legislature to provide private sector participation in rebuilding Alaska's depleted salmon fisheries. The impetus for the program came from the desire of commercial fishermen to enhance the severely depressed salmon stocks of the early 1970s. The program represented an unprecedented partnership among fishermen, processors, legislators and the Governor's Office.³⁸ The statutes for Private Nonprofit Salmon Hatcheries (AS 16.10.375-620 passed in 1974) authorized the Alaska Department of Fish and Game, FRED to issue hatchery permits to qualified PNP corporations. In 1976, the legislature authorized the formation of regional aquaculture associations. Regional associations are comprised of representatives of commercial fishermen and other user groups in the region, including sport fishermen, processors, subsistence fishermen and members of local communities.³⁹ Each regional association must have a board of directors consisting of at least one representative from each user group within the association. Currently there are seven regional aquaculture associations:

- Cook Inlet Aquaculture Association (CIAA)
- Lower Yukon/Kuskokwim Regional Aquaculture Association (LYKRAA)
- Northern Southeast Regional Aquaculture Association (NSRAA)
- Prince William Sound Aquaculture Association (PWSAC)
- Southern Southeast Regional Aquaculture Association (SSRAA)
- Imparik Regional Aquaculture Corporation (IRAC)
- Kodiak Regional Aquaculture Association (KRAA)

Regional Planning Teams

Three representatives from each regional association are appointed by their respective boards of directors to serve on a regional planning team (RPT) along with three Alaska Department of Fish and Game (ADF&G) personnel. These teams are responsible for developing regional comprehensive salmon plans for both FRED and PNP hatchery production. From FY 77 to FY 86, the legislature provided funds for planning teams via grants and contracts administered through the ADF&G commissioner's office. As of FY 87, funds for planning are no longer provided to regional associations.

³⁸Brian J. Allee, "The Private, Non-Profit Hatchery Perspective," Alaska Fish and Game, May/June 1986, p. 17.

³⁹Deborah L. Greenberg, "Alaska Fisheries Plan for Salmon," House Research Agency Memorandum 83-074, March 16, 1983.

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Phase I of each regional salmon plan includes: a regional profile; a determination of desired harvest levels (by species) user groups would like to attain at five-year increments through 2000; an assessment of the gap between existing harvest levels and desired levels; and a description of strategies or programs for achieving the stated objectives and goals. After extensive departmental review and public comment, a plan is accepted as amended by the Salmon Rehabilitation and Enhancement Coordinator in FRED and moves on to Phase II.

The Phase II process identifies a priority list of site-specific project ideas and enhancement potentials to reach the goals identified in Phase I. After the same sort of extensive review as Phase I, the Phase II plan is accepted and new proposals (e.g., a new hatchery facility, fishpass or lake fertilization project) are reviewed by the regional planning team with respect to the general goals and specific strategies identified in the planning process. Each RPT also produces an annual update of its salmon plan which includes any new enhancement opportunities identified by the private sector, ADF&G, the Forest Service, Fish and Wildlife Service or other interested parties. Currently, the Northern, Southeast, Southern Southeast and Prince William Sound Aquaculture Associations have completed Phase II plans while the Cook Inlet and Kodiak Associations are at the Phase I stage.

To date, 29 PNP hatchery permits have been received by FRED. There are presently 17 operational PNP hatcheries (eight regional association hatcheries and nine nonassociation "Mom and Pop" hatcheries). Six hatcheries are classified as not operational (of these one permit has been given up). The remaining six PNP hatcheries are somewhere in the permit process (see Figure 4 key).⁴⁰ Nonassociation operators do not have representatives on the regional planning team, and thus, no direct role (other than public comment) in setting harvest goals. Permits for nonassociation hatchery production capacity are reviewed by the RPT for consistency with planning goals.

STATE LOANS AND THE ECONOMICS OF PRIVATE NONPROFIT HATCHERY PRODUCTION

In 1976, the Fisheries Enhancement Loan Program was passed by the legislature to provide private hatchery organizations with the opportunity to acquire long-term, low-interest loans for hatchery planning, construction and operations. All private nonprofit hatchery operations (regional associations as well as nonassociation operations) are eligible for State loans. In 1982, the legislature modified the loan program to its present terms which allow a \$10 million maximum loan amount for an individual

⁴⁰"Private Non-Profit Hatchery Status Sheet," Alaska Department of Fish and Game, FRED, July 1986.

project with a payback period of up to 30 years at 9.5 percent interest. Payments on these loans can be deferred six to ten years.

The PNPs are allowed to sell surplus salmon harvested in terminal fisheries near the hatchery sites and spawned-out salmon carcasses to commercial buyers. Surplus eggs can be sold to other hatchery operators through FRED (which supervises and certifies all egg transfers). Regional associations receive revenues from assessment taxes collected on the gross sales of salmon harvested by commercial fishermen within the region (these funds are reallocated to the regional aquaculture associations via ADF&G contracts). Under the private nonprofit status, proceeds are allowed to be spent for reasonable operating costs (including debt retirement), expanding facilities, salmon rehabilitation projects, fisheries research and administrative costs of the qualified regional association for the area in which the hatchery is located.⁴¹ Table 4 lists the available information on cumulative State loans received by all PNP hatchery operations, enhancement funds (FY 77 through FY 86) received by regional associations and estimated annual fish sales for the 17 private nonprofit hatcheries in operation (through December 15, 1985). Note that several of the operations listed had more than one hatchery in operation.

⁴¹Alaska Statute, Section 16.10.450 "Sale of Salmon and Salmon Eggs by Hatchery."

TABLE 4

Cumulative State Loans (through August 7, 1986) and Enhancement Funds
Returned to Associations (through June 30, 1986) and Annual Fish Sales
for 17 Private Nonprofit (PNP) Hatcheries (through December 15, 1985)

Region/Corporation (Number of Permits)	State Loans		Cumulative Enhancement Funds	Grants* and Contracts	Estimated Revenue 1985 Sales of Fish
	Capital Construction	Operations			
<u>Southern Southeast</u>					
Southern Southeast Regional Aquaculture Assoc.--SSRAA (2)	\$ 9,093,000	\$2,848,942	\$ 5,516,643 (Note 1)	\$1,196,119	\$ 547,034
Alaska Aquaculture Foundation, Inc.-- AAFI (1)	1,053,285	1,200,275	N/A		3,369
Meyers Chuck Aqua- culture Assoc.-- MCAA (1)	10,000	0	N/A		0
<u>Northern Southeast</u>					
Northern Southeast Regional Aquaculture Assoc.--NSRAA (2)	2,714,405	1,351,573	3,647,119 (Note 1)	694,892	17,304
Armstrong-Keta, Inc.-- A-K (1)	1,152,145	875,500	N/A		15,000
Burro Creek Farms, Inc.--BCF (1)	27,500	255,875	N/A		1,745
Douglas Island Pink and Chum Corp.-- DIPC (2)	843,000	1,504,500	N/A		152,830