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With appreciation,

Dr. Sheila Wynn
Executive Director
Environmental Assessment Office

SALMON AQUACULTURE IN BRITISH COLUMBIA

SUMMARY REPORT OF THE SALMON AQUACULTURE REVIEW

In July 1995, the Minister of Environment, Lands and Parks and the Minister of Agriculture, Fisheries and Food asked the Environmental Assessment Office to conduct a review of the adequacy of current methods and processes used by the two ministries in regulating and managing salmon aquaculture operations in British Columbia. This is a summary of the Environmental Assessment Office's final report and 49 recommendations to the Ministers.

A. Salmon Farming in British Columbia

In salmon aquaculture (commonly known as salmon farming), salmon are raised in captivity from the egg stage until they are ready to be shipped to market. The process begins with the collection and fertilization of eggs from mature female salmon. The fertilized eggs are kept in incubation trays at company hatcheries. After approximately a month, the eggs are transferred to freshwater rearing tanks, where they are raised for several months to the smolt stage. The smolts are then transported from the hatchery to saltwater farms in coastal waters, where they are raised to market size.

Each farm typically consists of a series of open mesh net-cages suspended from anchored metal cage frames. Seawater passes freely through the cages, which average 15 metres square at the surface and are up to 10 metres deep. To a passing boater, the most visible aspect of a salmon farm is the walkways that separate the net-cages and provide access to shore.

Salmon farming is most productive in cool waters that are well flushed by tidal activity and protected from ocean storms. The waters of the Broughton Archipelago, on the northeast coast of Vancouver Island, and of several large sounds on the west coast are particularly well suited for aquaculture, and the large majority of salmon farms in B.C. today are located in these areas. In addition, other coastal areas such as the Queen Charlotte Islands hold potential for future development.

The industry was first introduced to the B.C. coast in the early 1970s. During these early years, two Pacific salmon species (chinook and coho) were farmed almost exclusively; later, for economic reasons, the industry switched predominantly to Atlantic salmon, a European and eastern Canadian species with a faster growth rate and greater tolerance for higher stocking densities. By 1988 there were 101 salmon-farming companies operating in B.C. Over the next four years, approximately one-quarter of these failed as a result of a drop in salmon prices, financial instability, or environmentally unsuitable farming sites. This period was followed by consolidation of ownership of many of the smaller farms, and the 79 active farms that remain today are operated by 16 salmon-farming companies. The industry currently accounts for over 2,200 person years of direct and indirect employment annually. These jobs have contributed to the economic well-being of a number of coastal communities and for those individuals involved, these jobs are extremely important.

Worldwide, salmon-farming operations now provide about one-third of the total annual salmon harvest. In 1995, the harvest of farmed fish accounted for approximately 37 per cent of salmon production in B.C.. Globally, the province's salmon aquaculture industry plays a relatively

insignificant role. The 25 thousand tonnes produced by B.C.'s farms in 1995 represented about 4 per cent of world farmed salmon production. Norway, Chile and the United Kingdom together account for 80 per cent. The rapid growth of the B.C. salmon-farming industry in the 1980s was accompanied by increasing public concerns about the impact of the industry on the marine environment and on other coastal users. The absence of a coordinated regulatory system and of legislative arrangements to deal with an increasingly significant industry provided a further cause of concern. In 1986, the provincial government placed a moratorium on the approval of new farms and undertook a public inquiry (the Gillespie inquiry) regarding the industry. The moratorium was lifted soon after the report from the inquiry was received. In addition to implementing most of the recommendations of the Gillespie inquiry, the government set up the Coastal Resource Interest Studies program to identify and attempt to address causes of local conflict. The Gillespie inquiry also led to the establishment of a Ministers' Aquaculture Industry Advisory Committee, a stakeholders' group with a mandate to advise the Minister of Agriculture, Fisheries and Food on the orderly development of the industry. In 1988, responding to several complaints about the industry, the B.C. Ombudsman's office prepared a special report on the administration of coastal resources. This report focused on administrative fairness and emphasized the need for integrated coastal zone planning, a coordinated regulatory framework, and the use of consensual dispute resolution techniques to deal with conflict fairly and effectively. Although governmental responses to the Gillespie and Ombudsman recommendations led to improvements in the regulation and administration of the industry, public concern about issues such as potential effects of interactions between wild salmon and escaped farm salmon remained strong.

All three formal levels of government—federal, provincial and municipal—currently have a role in regulating the industry. The role of First Nations in resource planning and management is evolving. In 1988, the federal and B.C. governments agreed on the division of responsibilities that exists between them today. The federal government, under the leadership of the Department of Fisheries and Oceans, maintains regulatory authority for the health of fish in aquaculture facilities, food and public health safety, conservation and protection of wild fish stocks and habitat, and protection of navigable waters. The provincial government has authority for overall development and management of the industry, including: location, size and development of farm sites, reporting requirements, and standards for design, construction and layout.

The provincial government's lead agency in dealing with the federal government on aquaculture issues is the Ministry of Agriculture, Fisheries and Food. As the agency that licenses aquaculture operations, the ministry controls most operational aspects of salmon aquaculture. The Ministry of Environment, Lands and Parks regulates siting and waste discharge permits. Applications for tenure (six-month investigative permits, 10-year licences or 30-year leases) on aquatic Crown land are assessed and approved or rejected by the ministry following field inspections and referral to other provincial and federal agencies, local governments, First Nations and interested non-governmental groups. Once a salmon farm tenure is approved, an operator must obtain an aquaculture licence, renewable annually, from the Ministry of Agriculture, Fisheries and Food. This licence contains requirements for compliance with an approved Aquaculture Development

Plan, prevention and reporting of escapes, appropriate attention to the biological needs of the farmed fish, predation and disease prevention, and compliance with laws and orders of all relevant governmental authorities. In addition to the Ministry of Agriculture, Fisheries and Food and the Ministry of Environment, Lands and Parks, the Land Use Coordination Office plays a role at the provincial level, as the agency that coordinates coastal resource inventories and Crown land planning processes. At the local level, regional districts and municipalities administer zoning bylaws and permits prepared in conjunction with Official Community Plans and Rural Land Use Bylaws. As well, First Nations in Clayoquot Sound and northern Vancouver Island have agreements with the province that provide for consultation in decisions regarding aquaculture.

B. The Salmon Aquaculture Review

In April 1995, the B.C. government placed a moratorium on the issuance of new farm tenures and announced an Action Plan for Provincial Salmon Aquaculture, which identifies the need for a definitive review of environmental issues and of provincial salmon aquaculture policies. The government assigned responsibility for the review to the Environmental Assessment Office. While the Environmental Assessment Office is not independent of government, it is not attached to any ministry and has no stake in the development or implementation of salmon aquaculture policies.

The Environmental Assessment Office was established under the *Environmental Assessment Act* in 1994 to conduct environmental impact assessments of major projects. Section 40 of the Act authorizes the Environmental Assessment Office to assess the effectiveness of other Acts and Regulations in B.C. in preventing or reducing adverse environmental effects. Recommendations made under this authority must be consistent with the *Environmental Assessment Act's* expressed purpose of promoting sustainability by protecting the environment and fostering a sound economy and social well-being.

The terms of reference for the Salmon Aquaculture Review, developed through broad public consultation, called for examination of five issues that have been central in the controversy about the salmon farming industry:

- **impacts of escaped farm salmon on wild stocks,**
- disease in wild and farmed fish,
- environmental impacts of waste discharged from farms,
- impacts of farms on coastal mammals and other species, and
- siting of salmon farms.

The terms of reference also provided that the review should include socioeconomic considerations in its assessment of the industry. During the review, the Ministers of Environment, Lands and Parks and Agriculture, Fisheries and Food confirmed that the review should include an assessment of alternative technologies.

The Environmental Assessment Office established a Technical Advisory Team of experts to prepare comprehensive discussion papers and make recommendations on each of the five key issues. In addition, a Review Committee comprising voluntary representatives of a wide variety of interests was set up to provide information, advice and comment to the Technical Advisory Team. The Review Committee held eight working sessions in several coastal communities in 1996 and 1997, providing the public with an opportunity to comment and present written submissions for consideration by the Technical Advisory Team. First Nations representatives, in addition to being part of the review committee and meeting independently with the Technical Advisory Team as a caucus, submitted papers on aboriginal perspectives on salmon aquaculture. The Broughton Archipelago, off the northeast coast of Vancouver Island, was chosen as a study area to document and demonstrate the issues. Field trips and public open houses in the area produced technical and observational information that was in turn provided to the Technical Advisory Team.

Once the Technical Advisory Team papers were completed, the Environmental Assessment Office evaluated the economic, social and administrative implications of their recommendations and prepared its final report for submission to the Minister of Environment, Land and Parks and the Minister of Agriculture, Fisheries and Food.

C. General Conclusions

The Technical Advisory Team concluded that salmon farming in B.C., as presently practiced and at current production levels, presents a low overall risk to the environment. However, this general finding is tempered by certain reservations. First, continuing concern about localized impacts on benthic (seabed) organisms, shellfish populations and marine mammals suggests the need for additional measures to protect them. Second, significant gaps in the scientific knowledge on which the Technical Advisory Team's conclusions are based point to the need for monitoring and research in areas such as the potential impacts of interactions of escaped farmed salmon with wild populations, identification and control of disease and disease pathogens, potential for disease transfer and impacts from antibiotic residues, and effects of waste discharges on water quality and seabed life.

Science rarely has the ability to reach definitive conclusions on the risk or potential severity of the consequences of human interactions with complex ecosystems. In the face of this uncertainty, government still needs to make land and resource management decisions. Direction is provided by the precautionary principle which advocates the consideration and anticipation of the potential negative impacts of an activity before it is approved. Similarly, the concept of preventative management allows government to manage to prevent certain specific effects even though not all potential outcomes can be predicted. Where the risk of environmental impacts from an economically important activity is low but the consequences of damage may be significant, the public interest may best be served by dealing with risk by being precautionary and invoking a series of measures, including: preventative management, adaptive management, and performance-based standards. In the case of salmon farming, this means reducing risk by setting high standards for farm operations based on the best available knowledge, and rigorously enforcing the implementation of those standards. And it means being prepared to alter management practices over time to take account of increased understanding of risk and different means of reducing it. This means that industry will be required to adapt to evolving management schemes.

The salmon farming industry has had a difficult beginning in B.C. It began in a regulatory vacuum, with little legislative or policy guidance and with no clear identification of regulatory responsibilities. Competition with other existing uses led to conflict and distrust from the outset, and insufficient consideration was given to potential impacts on environmental values. Farm practices have generally improved over the years, but in the absence of clear standards, consistent performance, strict enforcement of regulatory requirements and meaningful public participation in siting decisions, suspicion remains high and strong criticism continues. The concerns of those who find fault with government's management of the industry are legitimate and deserve to be addressed. The following sections highlight key points in the recommendations contained in the final report of the Salmon Aquaculture Review. The recommendations are reproduced in their entirety following this summary.

D. Siting and Environmental Issues

1. Salmon Farm Siting

The qualities that make a site suitable for salmon farming—good marine water quality, accessible shoreline, access to supplies of fresh water, safe moorage and proximity to population centres—are similarly attractive for other activities. The relatively recent appearance of salmon farms in areas of the coast where several other activities already exist or where other new activities (marine tourism) are growing have frequently led to conflict with other users. In addition to competition over surface uses, concerns continue to exist about localized ecological impacts of farming activity on marine species, including shellfish, benthic organisms, marine birds and mammals, and fish.

Much of the distrust about the siting of salmon farms that exists today stems from the 1980s, when the industry was growing rapidly and regulatory systems had had little chance to develop. The siting policies and procedures used by the Ministries of Environment, Lands and Parks and Agriculture, Fisheries and Food have improved since then, as have some of the farm practices that contributed to local conflict. Concerns remain with respect to the effectiveness of licensing arrangements and problems exist with the current location of some sites that were approved under former policies.

Despite current ministry policy requiring applications for farms within one kilometre of Indian reserves to be referred to First Nations, some applications were approved before the adoption of the policy, without such consultation. Of particular concern to First Nations is the fact that farm waste has been shown to affect life on the sea bed beyond the aquaculture tenure boundary. A complete understanding of the effects on shellfish resources, especially at a distance of 125 metres (the current minimum siting distance set by policy) are unknown. While there has been an improvement in procedures for considering and protecting key tourism and recreational values from visual and amenity disturbance, the requirements are vague and inconsistently applied. There is no policy requirement to identify and avoid prawn fishing areas, but known trap fishery sites are currently being avoided through siting. Likewise, efforts are made to avoid sensitive fish and wildlife habitat, but there are no comprehensive studies of overlap between salmon farms and sensitive habitats, and criteria for their protection need to be made more explicit. Navigation routes, archaeological sites and commercial and sports fishing areas are rarely affected by farm locations.

To identify potential impacts and conflicts in siting, the Ministry of Environment, Lands and Parks routinely refers applications to other agencies and interests. The effectiveness of the referral system is hampered by several factors: if comments are not returned in a timely manner, decisions may be made in the absence of full information; there is no obligation on the part of the Ministry of Environment, Lands and Parks to act on comments they receive; and there is no guidance for making tenuring decisions when conflicting advice is received. Even though the decision-makers have broad discretion, there are few effective avenues for consultations in advance of decisions. Recent initiatives to complement the referral process with face-to-face interagency communication, through the Vancouver Island Fish Farm Review Committee, have encouraged greater coordination and consensus, as well as enabling applications to be considered in groups. The committee approach to tenure review should be formalized, with provincial agency disagreements being referred to Interagency Management Committees for resolution. (Recommendation 1)

Another shortcoming of site-by-site referrals is that they restrict attention to a single site rather than considering the cumulative impact of multiple developments on a variety of values in a region or sub-region. Integrated coastal management plans, based on consensus among stakeholders and a thorough assessment of all biological resources, provide a fair and efficient mechanism for designating specific geographic areas suitable for different types and intensities of activities, including salmon farming. They should be prepared at both the sub-regional level (e.g., Central Coast) and the local level (e.g., Clayoquot Sound). As such plans may take considerable time to prepare, techniques should be developed on an interim basis to assess and allocate salmon farms in groups located within defined geographical areas and to provide for input of all those with an interest in such site allocations. (Recommendations 2 and 3)

To prevent or reduce negative impacts and conflicts, siting criteria should be established to define minimum distances for separation of farm sites from other uses and resource values, with greater than the minimum requirement being provided where detailed site-specific assessments show this to be necessary. (Recommendation 4) Where integrated coastal use plans provide clear direction, sites should be located in accordance with the plan. Thorough inventories and mapping, though expensive, generate cost savings by facilitating precise and expeditious decisions that avoid the risk of conflict by their increased credibility. They are essential both for integrated coastal planning and for the assessment of salmon farm site applications. Government should continue to improve its inventories and mapping base, drawing on federal and provincial data, local and traditional knowledge, and private industry maps. Aquaculture suitability maps should continue to be developed from this information. In addition, to facilitate informed decisions, government should require applicants to provide detailed assessments of specified site characteristics, using resource inventories and mapping, site surveys and studies, and local consultation. (Recommendations 5 and 6)

Despite a keen public interest in the aquaculture industry, current opportunities for involvement in decision-making regarding salmon farming are sporadic and limited. Public input is essential not only to encourage well-

informed decisions and reduce conflict, but as a matter of fairness. In addition to other avenues, government should establish local advisory working committees, comprising a balanced cross section of interests and using existing committees where appropriate, to provide advice on siting and management of farms. (Recommendation 7)

Where existing sites are poorly located and are causing significant problems, remediation plans should be developed, with measures to revise production levels, amend husbandry practices, incorporate different technology, or relocate farms to a different location. (Recommendation 8)

The early stages of the salmon-farming process take place in freshwater facilities, including land-based hatcheries and juvenile-rearing lake net-cages. Two Vancouver Island lakes (Lois and Georgie) currently have active aquaculture operations. Certain environmental impacts of salmon farming can be more significant in fresh water than in the ocean. There is an increased likelihood of escaped salmon competing with native fish populations and establishing colonies. In addition, low production or oligotrophic lakes are particularly susceptible to eutrophication resulting from absorption of waste nutrients. To reduce these risks, the government should prepare effective and consistent guidelines for approval of lake aquaculture facilities, and should develop and enforce water quality standards for dissolved waste discharges. (Recommendations 9 and 10)

2. Escaped Farm Salmon

Factors contributing to the escape of farmed salmon include deficient farm operations, damage to nets by storms or predation, accidents such as inadvertent release during transport, and vandalism. The Aquaculture Regulation requires licence holders to take reasonable precautions to prevent escapes and to report those that do occur. During 1994-95, B.C. salmon farms reported over 60,000 escaped fish (primarily Atlantic salmon), and total escapes may be double that number when unreported "leakage" is taken into account. In recent years the number of escapes has been gradually declining as a result of improved siting, farm design, farm practices and the introduction of acoustic deterrence of predators.

Given the importance of the wild fishery to the economic, social and cultural fabric of B.C., several strong and heartfelt concerns exist about the potential impact of escaped farmed salmon on wild stocks and the possibility of Atlantic salmon establishing in B.C. through reproduction. Deliberate attempts to introduce this species into B.C. in the past have failed. The Technical Advisory Team concluded that colonization by Atlantics is improbable but not impossible; if colonization were to occur, it would likely be possible to target and eradicate stocks that had become established. The Technical Advisory Team also found the potential for interbreeding between escaped Atlantic salmon and wild salmon to be extremely low and found little threat to wild stocks through predation or competition for food by Atlantic salmon. The introduction of an exotic species to the wild is a significant matter, as there are many past examples of damage caused by species presumed to be harmless. However, the risk of escaped Atlantic salmon causing lasting harm appears to be so low that there is no demonstrable basis at this time for discontinuing their culture in B.C.

The risk of genetic alteration due to interbreeding between farmed and wild Pacific salmon is potentially high if escape numbers increase, though B.C. already has a long history of intentional mixing of salmon with different genetic backgrounds through salmon enhancement programs. In addition to reducing the risk through escape prevention, care should be taken not to locate farms near streams that provide habitat for native stocks. Transgenic salmon (salmon that has been altered by introducing new genetic material into its genetic composition) might out-compete wild populations for food; farming of transgenics does not currently take place and should be prohibited. (Recommendation 11)

Current measures for the prevention, monitoring and reporting of escapes are ineffective and must be improved. Provincial agencies and industry should cooperate to develop information on the best available technology and husbandry practices for preventing escapes, and prevention measures should be included as enforceable elements of aquaculture management plans, with escapes over a designated threshold number triggering review and remedial measures. To facilitate monitoring of escapes and of farmed salmon inventories, farmers should be

required to maintain a computerized tracking system, with penalties for mis-reporting. Government monitoring of streams and of commercial and sport catches for escaped salmon should continue. (Recommendations 12 and 13)

In addition to reducing the risk of escape, more effective measures should be taken to reduce the potential impact of escapes that do occur. Salmon farmers should be required to develop plans for the recovery of escaped salmon, and research should be conducted regarding the development of stocks that pose a minimal genetic risk to wild salmon, including all-female or non-productive Atlantic salmon. (Recommendation 14)

3. Fish Health

Three primary concerns regarding fish health issues have to do with the risk of importation to B.C. of non-indigenous pathogens and parasites, transfer of disease between farmed and wild fish, and the use of drugs and pesticides on salmon farms. Significant gaps exist in scientific understanding of disease in wild and cultured fish. Current information indicates no evidence of exotic pathogens or parasites having been introduced to B.C., and the Technical Advisory Team found the probability of exotic disease outbreaks to be low. The susceptibility of farmed salmon to disease may be increased by the stress of being raised in captivity; however, it is not known whether there is a greater incidence of disease in farmed than in wild fish. Many farmed fish are vaccinated against disease. Primarily as a result of difficulties in monitoring disease and identifying the source of pathogens, there is no evidence to prove or disprove whether transfer of pathogens and parasites from farmed to wild stocks increases the rate of disease. Because of such information gaps, it is essential that government adopt a more proactive approach to disease prevention, with more rigorous research and monitoring.

A variety of federal and provincial government agencies (including the Ministry of Environment, Lands and Parks, the Ministry of Agriculture, Fisheries and Food, the Department of Fisheries and Oceans and Health Canada) are involved in the prevention and control of disease in farmed and wild fish. The importation of eggs and transportation of live fish are regulated under the provincial Freshwater Fish Regulation and the federal *Fishery General Regulations* and *Fish Health Protection Regulations*. Provincial legislation for animal disease control does not currently apply to fish disease.

Lack of coordination, good communication, clear objectives, and cooperation among the many agencies involved in the management of fish health create serious inconsistencies and redundancies. To overcome these inefficiencies, an interagency Fish Health Working Committee should be established with a mandate to develop management policies regarding surveillance, field investigations, inspections, assessments and reporting. The committee should address interagency disagreements through consensus-based decision-making.

(Recommendation 15)

The current approach to disease management is reactive rather than proactive. Little is known of the incidence of disease and disease-causing organisms in B.C. waters and of the ecological role of disease in regulating or affecting both wild and farmed populations. Current evidence suggests that all existing diseases on fish farms are indigenous rather than exotic, and that diseases are not transferred from farmed to wild fish, but more precise information is needed on the diseases that exist and on causal relationships in order to determine what diseases should be identified and reported by farmers. For these reasons, a comprehensive surveillance program is essential, in order to define all diseases that should be reportable. The program should be carried out by government under legislation (Animal Disease Control Act) with the participation of First Nations, industry, community fishers and wild fishery organizations. (Recommendation 16)

Currently, salmon farmers are required to take reasonable precautions to control disease. Government should set enforceable standards to establish disease prevention and management protocols, minimum health record requirements, outbreak management protocols, drug use standards and disease reporting requirements.

(Recommendation 17)

Development of effective vaccines, improved husbandry practices and a low level of drug use suggest that disease is not a significant problem to farmers. However, a lack of willingness on the part of industry and management agencies to share information has created a high level of public distrust. To counter this, a comprehensive fish health database should be developed containing fish disease and drug use information and should be accessible to the interagency Fish Health Working Committee. Information about diseases, pathogens and parasites should be made more readily available, provided that the proprietary interests of individual salmon farmers are protected and annual reports summarizing the results of the surveillance program and drug use in the industry, should be made available to the public. (Recommendation 18)

To further reduce the likelihood of disease transmission, government should, for salmonids, continue to prohibit the importation of live fish, unfertilized eggs and milt. The Technical Advisory Team found the likelihood of a serious disease outbreak resulting from importation of an exotic pathogen in fertilized eggs to be low but not zero, and the consequences of such an event could be significant. Importation of surface-disinfected fertilized eggs should be permitted only in limited numbers for broodstock development. Surface disinfectants, while generally effective, cannot remove all surface pathogens or pathogens within the egg, therefore multiple sampling of newly hatched fry is essential to ensure the fish are disease-free. Requirements for sampling and reporting of diseases in fish being transferred within the province should be strengthened. (Recommendations 19 and 20)

Both the federal and provincial governments, through a variety of statutes and agencies, regulate pesticide and drug use and the monitoring of aquaculture products, destined for human consumption. There is little risk of human consumers of salmon being affected by diseases in fish. Those pathogens that do affect humans, such as botulism, are usually the result of poor handling and preparation of fish. Drugs added to feed may be a cause of concern, but levels of use are low (about 2.1 per cent of feed used in 1995 was medicated). To guard more completely against the risk of drug contamination of salmon sold to consumers, government monitoring of fish products at processing facilities should be improved. In view of local concerns among First Nations about the risk of contamination of non-farm fish and shellfish that consume waste feed, flag indicators should be used at farms to alert the public when drugs are being used. As the use of antibiotics poses the risk of drug-resistant strains of bacteria developing, drugs should only be used under a veterinarian's prescription, with regular evaluation for changing patterns in bacteria. (Recommendations 21 and 22)

Certain issues, for example risks of those drugs approved for use in human food production, and the consequences of their use, fall under health agencies' jurisdiction. Health agencies should determine a course of action to deal with these issues, recognizing that although there are concerns, no extreme health effects have been identified.

(Recommendation 23)

4. Waste Discharges

Uneaten fish feed and fish faeces make up the bulk of farm waste discharges, with lesser amounts of effluent from workers, and garbage. Antifoulants may leach components into the water column. Solid wastes settle in the water column and on sediments below net-cages and are generally localized within 30 metres of the edge of the net-cage, their amount and degree of movement depending on the action of currents, efficiency of feeding regimes and other factors. Of particular concern, especially to First Nations, is the absorption of antibiotic residues from feed and faeces by marine life such as shellfish. One of the more persistent antibiotics, oxytetracycline, loses its effectiveness in the water column within 30 days, but overall information regarding the impact of antibiotics on marine biota is poor. Where waste accumulates to the point that it can no longer be absorbed by sediments and biota, biological degradation can lead to the production of toxic hydrogen sulphide and methane gases, and biota may be smothered by wastes.

Under the *Waste Management Act* and the *Aquaculture Waste Control Regulation*, farms that exceed minimum amounts in the use of feed (greater than 630 T per year) and discharge of domestic sewage, require permits that provide direction regarding good management practices. This approach has not consistently prevented impacts on the benthos (sea-bed life). More effective measures are needed to measure environmental impacts and to establish standards designed to limit sediment impact. Accordingly, the government should develop a regulation that encourages performance-based management, with clear and consistent standards, a requirement for farms to prepare enforceable waste management plans, and annual fees based on the type and amount of contaminants discharged by each farm calculated through feed use. Farmers should be required to carefully monitor the effects of wastes, making appropriate husbandry adjustments as necessary, and the Ministry of Environment, Lands and Parks should routinely assess monitoring data and be prepared to take immediate action to ensure compliance when standards are not met. A range of allowable limits may be required to account for variations in sediment characteristics, and initial testing and research will be required for the development and upgrading of standards. Until the new regulation takes effect, the existing regulatory regime should be applied and all tenure holders should be advised of the pending regulation which could affect their operations. Where existing farm sites are found to have a high adverse benthic impact, the Ministry of Environment, Lands and Parks should cooperate with farm operators to develop and immediately implement plans to improve benthic conditions or to relocate farms as a remedial measure. (Recommendations 24 to 30)

To address concerns about the impact of farm waste on nearby shellfish beds, provincial and federal agencies should cooperatively develop a program that provides a detailed assessment of that impact, especially with regard to antibiotic residues and suspended solids. The siting standards recommended by this report, especially with regard to distance from shellfish resources, should be reviewed once these assessments are completed and should be adjusted if necessary. (Recommendation 31)

The federal/provincial policy prohibiting polyculture should be reviewed due to the suggestion that shellfish grown near or on salmon farms can reduce particles in the water column. (Recommendation 32)

5. Interactions with Coastal Mammals and Other Species

Predation by seals, sea lions and river otters can cause considerable economic harm to salmon farmers through fish mortalities, wounds that lower market value, and stress that may cause fish to reduce feeding and increase their vulnerability to disease. Tearing of net-cages by predators can result in salmon escapes. In addition to losses caused by marine mammals, farms may face less significant losses to the predatory actions of mink and birds. An estimated 1.5 per cent of total industry production (in excess of 200,000 fish) was lost through predator-induced mortalities and escapes in 1989.

Methods used by salmon farmers to deter predator attacks include predator netting and other physical barriers, shooting, scaring devices (including gunfire, dogs and scarecrows), trapping, night watches, and acoustic deterrent devices (underwater sound-generating devices). Aquaculture licences require farmers to prevent predation, using reasonable and lawful means, and appropriate permits and authorizations are required for the trapping and killing of animals and the use of acoustic deterrent devices.

In the past eight years, over 3,800 harbour seals and California and Steller sea-lions have been reported killed by salmon farmers, and the total number killed may be significantly higher. This suggests that predator prevention efforts are generally ineffective, in part because some farmers are reluctant to invest in expensive predator netting. While overall populations of harbour seals and California sea lions appear not to have been adversely affected, there is strong public opposition to the killing of marine mammals, and shooting at current levels presents a public safety concern, especially at night.

Consequently, there should be tighter controls on shooting and greater efforts at predator prevention, with enforceable predator control plans written into aquaculture licences and government assistance in identifying the best available anti-predation net systems, other technologies and appropriate husbandry practices. Killing of predators should only be permitted if they are inside the nets and are actively attacking fish or about to do so. Farms with ongoing problems with persistent predators should contact government conservation or fisheries officers, who may at their discretion trap and kill predators and recommend improvements in a farm's predation prevention plan. (Recommendations 34 and 35)

Acoustic deterrent devices appear to lose effectiveness over time as seals and sea lions become accustomed to or deafened by them or are strongly motivated by hunger or previous predation success. In addition to causing hearing damage, acoustic deterrent devices may interfere with animal communication signals. Harbour porpoises are known to avoid traditional habitat where acoustic deterrent devices occur. As acoustic deterrent devices are generally ineffective and can pose a significant ecological hazard, they should be phased out over a two-year period and replaced with effective predator control programs. This will require cooperation from DFO. (Recommendation 36)

Several farms have been authorized by DFO to use night-lighting of net-cages to produce faster growth in salmon and to prevent certain maturation problems. The Salmon Aquaculture Review heard concerns that wild species such as herring are attracted by lights and are eaten by farmed fish, that the increased proximity of wild fish encourages the transfer of disease from farmed fish, and that bright lights at fish farms interfere with the aesthetic enjoyment of nearby residents and recreational users. One study has shown that fish in net-cages do not consume significant amounts of wild fish attracted by lighting. However, the paucity of research into this interaction combined with conflicting observational information suggests that further scientific study is needed. Accordingly, no new authorizations of night-lighting should be issued, pending the results of further research. (Recommendation 37)

E. First Nations Issues

The coastal areas best suited to salmon aquaculture overlap with the traditional territories of several of the Kwakiutl and Nuu-chah-nulth First Nations. Their legal interest in these territories is currently the subject of treaty negotiations although certain Kwakiutl First Nations are party to the Douglas Treaties. The rights of aboriginal peoples in their traditional territories, together with their traditional close relationship with the

resources of the sea, create strong concerns about activities that might affect the economy, culture and traditions of First Nations.

First Nations have received very few, if any, benefits from salmon aquaculture as it is currently practiced, yet they have experienced a greater impact than any other group. Their involvement in decisions regarding salmon aquaculture during the last two decades has been minimal. For these reasons and technical concerns, First Nations have strongly opposed salmon farming in their traditional territories.

Recent court rulings on aboriginal rights (primarily *Delgamuukw v. B.C.*) have established the provincial government's obligation to ensure that a proposed activity will not unjustifiably infringe aboriginal rights before approving the activity. To make that determination and to resolve any apparent conflict, adequate information (technical data and traditional knowledge) and appropriate consultation are needed prior to approval of aquaculture tenures. Where tenures are being considered for renewal or amendment, the vested rights and interests of tenure holders must also be considered.

With respect to the existing tenures, the government needs to conduct a review of existing tenures to determine which ones require consultation to ensure compliance with the current Crown Lands Activities Policy for avoiding infringement of aboriginal rights before a decision on renewal or relocation is made. For new tenures, affected First Nations should be invited to join government agencies on the Fish Farm Review Committees, which should have a primary role in reviewing tenure applications. These committees could provide an efficient mechanism for sharing information about proponent applications and First Nations concerns. In addition, government should consult directly with First Nations on tenure applications to ensure compliance with the Crown Lands Activities Policy and follow processes already established through interim measures agreements where these exist, including the Kwakiutl Territorial Fisheries Commission (for the Broughton Archipelago) and the Central Region Board (for Clayoquot Sound). (Recommendation 38)

In addition to their participation in tenure review processes, First Nations should be more directly involved in the management and operation of the salmon farming industry. Traditional knowledge about ocean resources has often been overlooked in the past, and could be a valuable asset in research, policy development, and monitoring and auditing industry operations. With this knowledge and their residence in the area where salmon farming is conducted, First Nations communities are well placed to provide support and technical services to farms in addition to working with government and industry to improve management practices. The government should

develop training programs and encourage employment of aboriginal people in the industry. In addition, First Nations should be involved in environmental monitoring and auditing, research on the impact of farms on seafood resources such as shellfish, and the development of pilot programs for closed containment technologies.

(Recommendation 39)

F. Addressing Risk and Uncertainty

While understanding of the risks inherent in salmon farming has increased significantly in recent years, it is incomplete. The Technical Advisory Team conducted a comprehensive review of existing scientific literature, research and observational information. It recorded the current state of knowledge, but gaps in that knowledge remain. Consequently, the Salmon Aquaculture Review has not provided unequivocal answers to all questions and concerns raised during the review.

Based on current knowledge, the Technical Advisory Team found a low overall risk in the key areas of concern but some local impacts. Different interests in the public debate over the future of salmon farming react to such a finding in very different ways. Proponents of the industry argue that approval of industry expansion should naturally follow. Some opponents argue that, without proof that there is no risk to the marine environment, net-cage farming should be prohibited completely and replaced with closed-containment systems.

Scientific studies rarely eliminate uncertainty. However, by defining the boundaries of uncertainty, such studies can delineate information gaps and provide a focus for ongoing research. It is the role of government to act on that information and make decisions, to the best of its ability, that protect environmental values while enabling economic progress. This means acknowledging uncertainty where it exists and dealing with it in a precautionary manner. This is accomplished by first anticipating potential negative impacts, and invoking preventative measures to avoid specific effects. It also involves ongoing adaptive management, in which knowledge gaps are identified, research and monitoring needs are defined and implemented, and management and regulation are adjusted as necessary to take account of new information and minimize risk to the degree possible. The Environmental Assessment Office concludes that an adaptive management approach should be taken to the sustainable development of the salmon aquaculture industry.

Within the limits of its resources, government should place a priority on research on each of the four key issues where uncertainty exists: escaped farm salmon, fish health, waste discharges, and interactions of salmon farms with aquatic mammals and other species. Priority research is also needed to assess the effects of salmon farming, particularly when antibiotics are used, on human health. Industry, as a beneficiary of the results of research on each of these issues, should share in the effort and cost. To complement solutions through research, the government should monitor the adequacy of current management techniques through continuous collection and analysis of standardized data. The information gained through research and monitoring on each issue should be applied through the ongoing refinement of standards. (Recommendations 40 and 41)

Even though the risk of significant environmental impacts has been determined to be low, the possibility nevertheless exists for the occurrence of a catastrophic event such as damage to wild salmon stocks through disease transfer or the importation of pathogens. Some participants in the Salmon Aquaculture Review argue that the industry should be required to post a sizable financial bond to provide the funds needed to remedy ecological damage and compensate for economic loss. The Environmental Assessment Office has recommended a range of measures to prevent risk and to ensure information to manage critical issues as a means of preventing a significant event. Should one occur, existing measures should be relied upon to recover the costs of such an event (*Environmental Management Act; Animal Disease Control Act*) and strengthened if necessary. The industry reclamation bond should be reviewed for adequacy. It is currently set at \$25,000.

G. Alternate Salmon Farming Technologies

The grow-out phase of salmon aquaculture in B.C. is conducted entirely with floating net-cages in the sheltered waters of Georgia Strait and the protected sounds and inlets of the west coast of Vancouver Island. This system has the advantage of being easy to operate, requiring relatively low capital investment, and allowing for

incremental change in production capacity with little alteration of a facility. Other technologies, already in use in other countries or currently being developed, have varying potential to reduce environmental impacts of salmon farming, increase the efficiency of culture methods, and allow for expansion into areas where conflicts with other activities may be lessened. These alternative technologies include exposed offshore open marine systems, closed circulating marine systems, and land-based saltwater systems.

Exposed offshore open marine systems. Offshore systems, located anywhere from a few hundred metres to a few hundred kilometres from shore, are exposed to larger waves and potentially higher currents than inshore sites. While the environmental conditions are more harsh, production benefits may be increased as a result of consistently higher water quality and more active tidal flushing.

Developments of offshore finfish aquaculture operations include both surface and submersible cages, which in some cases are mounted on the seabed and operated from the surface. Offshore cage designs are technically feasible and are operating successfully throughout the world. While the cost of switching to such a system and of adopting new culturing methods may be considerable, there would be economic advantages to the industry in increased productivity and expansion opportunities. Some coastal communities, however, may experience an economic disadvantage through the loss of processing and income from services if better product distribution services afforded by larger centres become more accessible.

Environmental impacts such as benthic smothering, enhanced nutrient loadings and predator interactions would generally be lessened, as would be conflicts with other coastal resource users and interest groups. Other potential environmental impacts associated with deep-water siting require assessment. The risk of large-scale escapes through structural failure or collision with a vessel might increase, but could be manageable with proper engineering and safety precautions. Because the locations of offshore systems would in many cases occur outside of the area within authority of British Columbia, many aspects of siting decisions and industry management would likely fall within the mandate of federal agencies.

In order to determine whether to support a shift to offshore systems, the provincial and federal governments should clarify their jurisdictional and management responsibilities and assess the social, economic and environmental impacts of offshore systems. (Recommendation 42)

Closed, circulating marine systems. The two main design types that have been conceived for this technology are closed-wall cages and floating raceways. The closed-wall cages resemble the net-cages currently in use, with the exception that an impermeable membrane replaces the net and water is pumped into the cage.

While closed, circulating marine systems are becoming technically feasible, components such as systems for collection of solid waste require further development. Commercial feasibility remains to be demonstrated. Some environmental impacts, such as escapes, predator interactions and contamination by waste, can be lessened considerably through this technology, though the high volume of water required may have an effect on plankton and on larvae and juveniles of other species. Conflicts with other coastal users would continue to exist and might increase if the technology allows siting in more sheltered locations.

The Ministries of Agriculture, Fisheries and Food and Environment, Lands and Parks should establish a task force, comprised of industry, First Nations and all levels of government, to select sites for the establishment of pilot projects for closed systems. These projects, in a variety of habitat types and locations, should be used to encourage further development of the technology needed to establish economically viable farms with minimal environmental impacts. The salmon farming industry should participate in the cost of developing this technology and other research through funds generated by the establishment of a research and development fund.

(Recommendations 43 and 44)

Land-based saltwater systems. In the most basic form, these consist of deep water ocean or saltwater aquifer intakes, pumps and pipelines, saltwater ponds, effluent structures and site buildings. Other components that may be added as the sophistication of the technology increases include oxygenation, effluent clarification, treatment of

sludge, removal of nitrogenous waste, ozone or ultraviolet disinfection, temperature modification and recirculation.

While a land-based system with recirculation technology would minimize many current concerns about environmental impacts of salmon farming, there are also significant disadvantages. Technologies exist but capital and operating costs would both be extremely high, given those existing technologies. Geographical requirements—a large flat location near sea level, with a deep ocean water source close by—suggest limited availability of suitable land in B.C. as well as a high potential for conflict with adjacent property owners. Land-based saltwater systems are not currently a viable alternative to other salmon aquaculture technologies for commercial grow-out given the need for foreshore land and high, uneconomic cost of production.

H. Dispute Avoidance

Implementation of the recommendations in this report should significantly contribute to avoiding disputes as a means of reducing the level of the conflict that has plagued government in managing the salmon farming industry during the past decade. Nevertheless, disputes may be expected to occur from time to time with regard to both regulatory decisions and operational practices and performance. Mechanisms are needed to deal with such disputes in an efficient, fair and effective manner.

Siting decisions are critical decisions both because of their impact on local communities and the environment and because they represent a long-term commitment ranging from 10 to 30 years. It is therefore essential that they be based on processes that are seen to be fair and effective. An improved information base and better siting criteria will assist in making better decisions. Strengthened processes for public and First Nations participation, with assurance that public concerns will be heard and considered, are recommended. Interagency coordination and cooperation need to be improved to ensure efficient sharing of information and resolution of differences.

Integrated coastal zone planning is an essential initiative to tie these components together, by providing for a consensus-oriented decision-making process that brings together all affected public and government interests and places aquaculture in a broader planning context.

Disputes about specific siting and permitting decisions can be avoided or addressed through several steps.

Licensing agencies should establish procedures and mechanisms, including a Ministry of Agriculture, Fisheries and Food website, to effectively inform the public about the status of tenure and permit applications, and provide an appropriate period for public review and comment. Farm proponents should be required to hold open houses and to meet with local advisory working committees to explain and receive comment on their proposals. The government should take steps to ensure that affected parties are made aware of their right to register a formal objection to a site application with the Ministry of Environment, Lands and Parks. Members of the public will be participants on the local advisory working committee. (Recommendation 42)

Several participants in the Salmon Aquaculture Review expressed frustration that there is no effective means of influencing or registering complaints about poor performance by farms. Three avenues for complaint currently exist. First, complaints to the appropriate licensing agency may lead to an investigation and enforcement or cancellation of a licence where an operator has failed to comply with its terms or conditions. Second, persons who are concerned about a farm impact such as noise, light or odour can contact regional Ministry of Agriculture, Fisheries and Food staff, who will attempt to develop solutions through discussions with the complainant and farmer. And third, since April 1997, individuals can file a complaint with the Farm Practices Board, an independent body established under the recently adopted *Farm Practices (Right to Farm) Act*. If informal resolution is not successful, the Board may hold a formal hearing to determine whether a practice being complained of is “normal farm practice”; if not, the board may order the practice stopped or modified. Each of these dispute resolution mechanisms has the potential to be effective and should be encouraged.

I. Policy Context and Advice

Provincial staff responsible for developing and implementing salmon aquaculture policies and procedures have been hampered by the absence of government-wide direction on environmental, economic and social objectives.

The draft provincial land use goals and the guiding principles contained in the Provincial Land Use Charter and Sustainable Environment Charter have not been applied specifically to aquaculture. This lack of direction has contributed to disagreements among the various agencies involved in the administration of the industry and has encouraged inconsistency among agency-specific policies. With the participation of all key groups and agencies, the government should take steps to develop strategic policy objectives to guide the development of legislation, regulations, programs, policies, guidelines and coastal zone planning processes. (Recommendation 46)

Generally, the development of the industry has outpaced government in planning and managing it. Laws, regulations, policies and guidelines, while continuing to improve, have fallen short of the expectations of groups such as First Nations, local government, commercial fishing, recreation and tourism interests. The Minister's Aquaculture Industry Advisory Council effectively involved several of these interests in providing advice on policy development until 1993, when it disbanded. The government should create a similar body, including representation from all key interests, to provide advice on the development of policy, monitor its implementation, recommend research priorities, and provide a forum for dialogue and information exchange. (Recommendation 47)

J. Implementation of the Recommendations

1. Environmental, Economic and Social Implications

Implementation of the recommendations of the Salmon Aquaculture Review will reduce both uncertainty about and risks of negative ecological impacts from salmon farming, as described in the foregoing discussion of siting and environmental issues. Preventative and adaptive management and performance-based standards are crucial in achieving this goal. The agencies involved in the regulation of the industry should be prepared to adjust policies and practices periodically as knowledge gained through research and monitoring continues to evolve. Farm operators are currently subject to very few objective and measurable (and thus easily enforceable) performance standards. The proposed shift to a regulatory system that emphasizes clear and objective standards will contribute to the prevention or reduction of undesirable environmental impacts.

The real and potential economic benefits of minimizing these risks will include: increased stability and sustainability for the salmon-farming industry, reduced costs in conflict management, reduced risk to commercially valuable wild fish and shellfish populations, and benefits to the outdoor recreation and tourism industries. The economic cost of implementing the recommendations, if adopted, will affect the aquaculture industry, the provincial and federal governments, as well as First Nations and local governments.

The administrative and regulatory costs to the provincial government of implementing the recommendations over the next three years are expected to amount to approximately \$2 million to \$4 million. The cost impact will fall primarily in three areas: fish health surveillance, data management and auditing; development and enforcement of performance standards required of farm operators; and research initiatives.

Costs to the federal government will be related directly to existing responsibilities for the stewardship of wild salmon stocks and other marine species. These costs would include involvement in the establishment of an interagency working committee on fish health; diagnostic and disease identification work; improved inventories and classifications of anadromous fish streams; and participation in coastal zone planning.

Costs to the industry would be associated with new process requirements for siting, escape prevention and mitigation, waste control and predator prevention. Implementation of the recommendations will alter the availability of sites. While some areas may become less available, others are likely to be opened up through coastal zone planning. Moreover, as farming technology improves, deeper, more exposed waters may become suitable for farming, and closed containment systems may increase near-shore opportunities. The primary cost to the industry with regard to a review of tenures is likely to result from the need to relocate or fallow existing farms that have undesirable impacts on benthic biota and nearby shellfish beds. Where these impacts result from inappropriate siting decisions in the past, it may be reasonable to expect that government would contribute to the costs of relocating farms, which may be expected to average about \$50,000 per farm affected.

While it is in the industry's own economic interest to reduce the risk of escapes, disease and predator attack, implementation of the recommendations will result in certain new costs to industry. Escape prevention and mitigation costs will include the expense of developing and implementing escape prevention plans, of standardized inventory control systems, and of escape recovery plans and equipment. The recommendation that farms be subject to enforceable fish health standards is unlikely to create significant new costs to the industry beyond those already experienced in the vigilant efforts that currently exist to ensure healthy farmed populations. The recommendation for increased emphasis on physical barriers to predators rather than acoustic deterrent devices and shooting will result in increased costs for the installation and maintenance of new net systems, which are currently not in use on about one-third of B.C.'s farms. While the cost for such systems is high—about \$250,000—savings may result from reduced financial losses due to escape, mortality, injury and stress in farmed stocks.

The marine tourism industry is one of the fastest-growing sectors of the economy and rivals the employment contribution of salmon-farming in areas such as Clayoquot Sound. Pristine environments are important attributes for activities such as kayaking and whale-watching, and growth in the coastwide number of salmon farms could

result in forgone opportunities for marine tourism operators. However, they may benefit from the implementation of recommendations regarding the phasing out of acoustic deterrent devices, limiting of night-lighting, improved control of waste discharges, separation of sites from key recreation/tourism sites, and preparation of coastal zone management plans.

Implementation of the recommendations may be expected to confer a variety of social benefits on coastal communities. Provisions to address concerns about environmental impacts and to increase public participation in siting decisions should lead to a reduction in conflict, and industry stability should have a positive effect on local employment. First Nations should benefit through increased involvement in decision-making processes, reduced risk to marine resources such as shellfish, and a range of new employment opportunities. Conflicts between salmon farms and marine recreation activities should be reduced by distance restrictions on siting, identification of sensitive areas through improved inventories and mapping, and minimization of visual impacts through design guidelines in an aquaculture code of practices. Finally, development of coastal zone management plans, based on comprehensive and reliable information and on consensual agreement among stakeholders, provides a promising opportunity to balance competing community interests and produce stability and sustainability for a broad range of ocean-based activities.

2. Implementation

The capacity of provincial and federal agencies to implement change quickly in the reform of salmon aquaculture management is constrained by structural reorganization and budget limitations. For that reason it is important to establish priorities in the implementation of the Salmon Aquaculture Review's broad range of recommendations. Immediate emphasis should be placed on promoting effective public participation in decision-making and information-sharing among all parties with an interest in salmon aquaculture issues. First Nations, community groups, environmental organizations and recreation/tourism interests have all expressed deep distrust of the industry and the agencies that regulate it. Meaningful public involvement is necessary not only to address concerns about perceived industry secrecy and government failure to respond to public concerns, but also to ensure that decisions are informed by important local knowledge and technical information. Local advisory working committees should be initially established to provide advice in areas where new sites may be allocated or existing licences are due to be replaced.

The recommended salmon aquaculture advisory group on policy development should be set up with the initial tasks of providing advice on implementing management improvements and a code of salmon aquaculture practices. The code should take the form of a single reference document that identifies all standards and guidelines for the development and operation of salmon farms. Developed cooperatively by government, industry and other key interests, the code would be a primary source for salmon farmers in developing farm management plans and describing specific measures to be used to prevent or mitigate escape, maintain and monitor fish health, contain waste, and deter predators.

Before a performance standard for waste discharges can be established, considerable work needs to be done. Information about the impact of waste from current farms on water quality and benthic life is limited, and that which does exist has not been fully utilized. Intensive monitoring of several key sediment and water quality parameters at salmon farms should be conducted, and the results should be correlated to biodiversity impacts beneath salmon farms, with consideration also given to economic implications for the industry.

A comprehensive code of salmon aquaculture practice that establishes best operational practices and describe application processes as well as methods to address complaints and resolve disputes is a critical component of the proposed management framework. (Recommendation 48)

Legislative, regulatory and policy changes are outlined and should be made to implement the recommendations. Operational policies are needed to implement many of the changes. Processes for the review of tenure applications, salmon aquaculture licence applications and waste management plans are recommended and policy guidelines should be issued to endorse and adopt these. A corporate enforcement and compliance policy should be documented by the managing agencies to provide greater certainty and fairness to the industry and public. (Recommendation 49)

While the Salmon Aquaculture Review has determined that the overall risk to the environment from salmon farming is low, caution needs to be exercised about lifting the moratorium on new tenures before a new management system is fully in place. The government may wish to consider developing selective regional or sub-regional coastal strategies for the issuance of new tenures, where government is confident that issues can be managed. Strategies would have to take into account the need for sites for relocation of farms due to poor siting conditions and First Nations issues (demonstrated through consultation and information assessment). In areas of scarce resource availability, once an area is reserved for relocation, government should consider identifying suitable sites, in consultation with local interests, and allocating them through a competitive proposal call. This approach would allow tight controls pending the implementation of management system reforms and coastal management planning processes.

Immediate direction should be provided to the Central Coast and Queen Charlottes land and resource management process to address salmon aquaculture issues. Comprehensive aquaculture licences could be issued for new farms that impose many of the new operational requirements on a farm by farm basis until regulations are developed. Other priorities in the implementation of the recommendations should include pilot projects to test alternative farming technologies (closed-containment), and research to address significant gaps in information about potential results of interactions between farmed and wild salmon and localized effects of salmon farming.

3. Summary of Recommendations

The following is the full text of the 49 recommendations made by the Environmental Assessment Office in the final report of the Salmon Aquaculture Review.

CONSOLIDATED LIST OF RECOMMENDATIONS

The following are the recommendations made throughout this report, and extracted from the full text for ease of reference.

Salmon Farm Siting

Recommendation 1: Establish permanent regional Fish Farm Review Committees to ensure coordinated salmon farm siting and management decisions.

- The existing Vancouver Island Fish Farm Review Committee should be confirmed for that region as a permanent structure for making recommendations on site tenure and aquaculture license issuance, replacement, modification and enforcement.
- Similar committees should be formed for other administrative regions, as appropriate (e.g., Lower Mainland region; Central Coast region).
- First Nations in whose territory salmon farming applications are made should be invited to join the committee; local governments in the area of the tenure application should also be invited to serve as members and to establish liaison with the local advisory working committee proposed in Recommendation 7.
- The regional Fish Farm Review Committees should establish their rules of operation including the use of consensus principles and should provide advice to statutory decision-makers. Where the provincial agencies experience disagreements that cannot be resolved within the committee, differences should be referred to the appropriate regional Inter-agency Management Committee for guidance or decision, or to the appropriate Assistant Deputy Ministers or Deputy Ministers.

Recommendation 2: Develop integrated coastal zone management plans.

- The province should, over time, prepare integrated coastal zone management plans that designate specific geographic areas that are suitable for different intensities and types of activities, including salmon aquaculture.
- The province should complete the Land and Resource Management Plans (LRMPs) for Central Coast and the Queen Charlottes in accordance with announced policy and timing, and should include salmon aquaculture in the terms of reference for each LRMP.
- The coastal zone management plans should be based on a thorough assessment of all biological resources in relation to the interests and demands of coastal users.
- Coastal zone management plans should be developed with the participation of all key stakeholders in a consensus-seeking setting.
- Plans should be prepared at both the subregional level (e.g., Central Coast) and at the local level (e.g., Nootka Sound).

Recommendation 3: Pending the development of coastal zone management plans, proactively identify and allocate suitable salmon aquaculture sites.

- Pending the development of fully integrated coastal zone management plans at the sub-regional and local levels, the provincial government should employ site allocation techniques that assess and allocate individual salmon farming sites in groups on a "regional" basis, where other uses are considered concurrently, and opportunities are provided for federal and provincial agency, First Nations, local government, and public input.
- Salmon farming sites that are identified using this approach should be granted through a competitive proposal calls process where proposals are evaluated on the basis of environmental, economic and social criteria. The evaluation framework for such proposals would require development.

Recommendation 4: Adopt revised salmon farm siting criteria.

- Salmon farms should be sited using the criteria shown in Table 13 in locations where:
 - there is no integrated coastal land use plan or local government zoning bylaw already in place that provides clear direction on salmon farm siting, and
 - government has not conducted an "interim" salmon aquaculture-related planning process to pre-select and market salmon farming sites.
- These criteria should be adjusted over time to respond to new information and possibly to respond to new technology.

Recommendation 5: Require salmon farm applicants to submit an assessment of proposed salmon farm sites and potential impacts on other resources and uses.

- As part of the standard salmon farm site application procedure, applicants should be required to submit a package of information describing the resources and uses affected by the proposed farm, and potential impacts on environmental resources, human populations and user groups.
- The FFRC should, on a priority basis, document guidelines for use by proponents in developing an application.
- The site assessment should be assembled by qualified individuals using government resource inventories and mapping, site surveys and studies, and local consultation.
- Government should prepare a guide for the preparation of site assessments which contains advice to proponents on information sources, and documents appropriate site assessment methods and content of site assessment submissions, including required categories of impact, map scale requirements, local consultation requirements, and submission format.

Recommendation 6: Continue to improve the quality of coastal resource inventory mapping.

- Government should continue to develop and improve inventories and mapping of coastal resources (at map scales ranging from 1:250,000 to 1:20,000) as a key tool for integrated coastal zone planning and management, and for salmon farm siting decision-making.
- Government inventories and mapping should incorporate federal and provincial databases, local and traditional knowledge, and mapping assembled and provided by private industry.
- Salmon aquaculture suitability maps, based on best available inventory information, should be prepared that classify the relative potential of B.C.'s coastal areas for salmon farming use. These maps should be used to counsel salmon farming proponents on appropriate salmon farming locations to pre-select and market suitable salmon farm sites, and as an important information input into coastal zone planning processes.
- Coastal resource inventory information should be available to agencies and other interested parties in both hard copy and electronic format at reasonable cost. The province should develop and implement a standardized policy respecting the public distribution and costing of this information, as a basis for facilitating its wide availability and use. Sensitive First Nations cultural data respecting resource harvesting and traditional use areas should continue to be protected, unless the relevant First Nations approve the release of those data.

Recommendation 7: Ensure the opportunity for public participation in salmon farm siting and management decisions by establishing local advisory working committees.

- Establish local advisory working committees, comprising a balanced cross section of local interests, to advise government on salmon farm siting and management questions.
- Committees should establish their operating procedures and accept comment from the public on a salmon farm siting proposal for a period of time established by the committee once the public have been notified of the proposal.
- Invite local government representatives to serve as liaison between this committee and a regional Fish Farm Review Committee.
- Utilize appropriate existing committees for this purpose wherever possible (e.g., existing LRMP Table sub-committee, Local Round Table, Community Resource Board, or Advisory Planning Commission) and call on federal and provincial agencies from the FFRC as needed.

Recommendation 8: Assess existing salmon farms to determine if the farms are causing significant negative impacts that need to be corrected.

- MAFF, MELP and DFO should cooperate in an assessment of all existing salmon farm sites to identify whether or not the farm is causing significant negative impacts and conflicts that require remediation.
- Agencies should prioritize existing salmon farms for site evaluation, based on:
 - knowledge of past performance at the site,
 - available site monitoring information,
 - the point at which the site tenure comes due for replacement, and
 - concerns raised by First Nations.
- Where it is concluded from a site assessment that an existing salmon farm is causing significant impacts that need to be addressed, the above agencies should cooperate with the farm operator to prepare a remediation plan. The plan might include measures to reduce production levels, amend husbandry practices, introduce new technology, or relocate the site.
- Where government requires immediate remediation by salmon farmers whose site tenures and other licences/permits are in good standing, then remediation costs should be borne by the provincial government, recognizing that those salmon farmers are operating in compliance with approved licences and permits. Where the need for remediation is less pressing, government may elect to put the tenure holder on notice that remediation will be required as a condition of site tenure replacement, making the costs of remediation the responsibility of the operator.
- An assessment of resources needed to support site relocation should be made by MELP and MAFF prior to considering new tenure applications or preselecting tenures for competitive bidding (refer to Recommendation 3) to ensure existing tenure holders' needs are met.
- Agencies should consult with First Nations in developing a strategy for the review and prioritizing of sites causing significant negative impacts as recommended in Chapter 9.
- Tenure holders should be consulted and be a part of this strategy.

Recommendation 9: Develop and implement consistent guidelines for assessing and approving salmon aquaculture facilities in freshwater.

- Government should prepare and adopt standardized guidelines for assessing eutrophication risks, and risks to indigenous fish populations from escaped young salmon, which are potentially associated with salmon aquaculture activities in freshwater lakes.
- Government should prepare and adopt standardized guidelines for location and construction standards of hatcheries.
- The guidelines should reflect that salmon aquaculture facilities in freshwater lakes will be authorized only where risks of negative eutrophication impact and risks to indigenous fish populations are low.
- No new salmon aquaculture development in freshwater lakes should be approved until the proposed guidelines are in place.

Recommendation 10: Develop and enforce water quality standards for dissolved waste discharges from lake cage operations.

- MELP should establish and enforce water quality standards for dissolved waste discharges from aquaculture facilities in freshwater lakes.
- The standards should be made enforceable through regulation under the *Waste Management Act*. Operators should be responsible for regular water quality monitoring and submission of monitoring data to MELP.

Escaped Farm Salmon

Recommendation 11: Continue to allow both Pacific and Atlantic culture, but restrict the species farmed to take into account local site conditions.

- Government should continue to allow both Atlantic and Pacific salmon to be farmed in marine net-cages.
- Government should prohibit farms with Pacific salmon from being located near streams with sensitive wild stocks.
- Government agencies should further develop existing stream classification programs to ensure accurate data regarding the current status of salmon stocks in coastal streams is available for the appropriate siting of salmon farms.
- Government should continue to prohibit the commercial farming of transgenic salmon in marine net-cages.

Recommendation 12: Advance the goal of eliminating escapes by focusing on escape prevention as the principal management strategy for eliminating and/or reducing ecological risks from salmon farm escapes.

- Government should amend the Aquaculture Regulation to:
 - establish a requirement for salmon farmers to specify in an aquaculture operational plan, the specific measures (i.e., technological/engineering controls and husbandry practices) that will be adopted at the farm to prevent farm salmon escapes and constitute enforceable elements of the aquaculture licence, and
 - establish a specific requirement written in the aquaculture licence for salmon farmers to keep the level of escapes from their farm within a threshold of three per cent of total fish stocked. If the threshold number is exceeded (through individual escape "events" or through chronic leakage), the farm should be subject to a review of the aquaculture operational plan, with modification to the escape prevention measures that are specified in the management plan being required if deemed inadequate.
- Failure to comply with regulatory requirements should lead to disciplinary measures such as fining or licence revocation.
- Provincial agencies and industry should, as part of an overall salmon aquaculture "code of practice," cooperate to develop and maintain a description of best available and feasible technology and husbandry practices for preventing escapes. This information should be made available to salmon farmers for use in developing modern and effective escape prevention measures in their individual aquaculture operational plans.
- Provincial agencies should regularly review the threshold number of salmon escapes and reduce it as warranted based upon improvements in technology, husbandry practices and demonstrated ecological need. The threshold should be lowered to as close to zero per cent as possible within five years.

Recommendation 13: Implement a mandatory standardized information collection and reporting program.

- Government and industry should further develop the existing computer-based inventory tracking system into a standardized system that is implemented industry-wide. This inventory system should clearly show: numbers of salmon transferred to each farm, numbers lost to disease, numbers lost to predation, numbers lost to chronic leakage, numbers lost due to escape events, numbers of recovered salmon, numbers harvested, and date and size of fish at each event.
- All farms should be required to maintain this inventory tracking system and report this information to government for every production cycle as a condition of the salmon aquaculture licence. These data should also be open to government inspection at any time.
- Inventory data should be made available to the public in a manner that protects proprietary information through annual reports prepared on a regional basis by MAFF.
- Farms that are proved to be misreporting numbers should be subject to disciplinary action.

Recommendation 14: Reduce the risk of ecological effects from escaped farmed salmon.

- Adopt regulatory measures that minimize the potential for ecological risks from farm salmon that do escape, recognizing that although strategic priority should be on escape prevention, the likelihood of escapes of at least minimal numbers will remain. The measures should focus on remediation of significant escape events through adoption and implementation of escape recovery plans. A regulatory approach to enabling escape recovery plans will be required from DFO.
- Require salmon farmers to develop approved regional strategies for escape recovery and farm-specific escape recovery plans in consultation with federal and provincial agencies with the mandate to regulate and manage wild fisheries.
- Require salmon farmers to keep the level of escapes from their farm within a threshold number that is specified in their licence document. If the threshold number is exceeded through individual escape events, then the farm must implement the escape recovery plan. Salmon farmers failing to implement the escape recovery plan should be subject to disciplinary action.
- MAFF, in consultation with MELP and DFO, should work with industry to define an appropriate threshold number that would be applicable to all farms, and should produce a guide to assist industry with the development of effective escape recovery plans.
- Continue and expand the Atlantic Salmon Watch Program to help determine the fate and behaviour of escaped Atlantic salmon.
- Conduct research, subject to consideration of other research priorities, into further domestication of farm salmon and development of all-female or non-reproductive Atlantic salmon. Designate agency personnel to regularly review and report on the results of other relevant research.
- Monitor other relevant research being conducted in B.C. and other jurisdictions for results useful to improving the management of salmon farming in B.C.

Farm and Wild Fish Health

Recommendation 15: Establish a Fish Health Working Committee to promote integrated and corporate fish health policy development in B.C.

- Government should mandate a Fish Health Working Committee to develop and oversee management policies concerning all aspects of fish health, including: field investigations and surveillance, inspections, monitoring, assessment, and reporting.
- The committee should comprise federal and provincial representatives with demonstrated expertise or resources in the fields of: fish biology and physiology, fish disease science, and pharmacology.
- The terms of reference for the Fish Health Working Committee should specify that the committee will solicit input and advice from interested parties, including: First Nations, MOH, Health Canada, Agriculture and Agri-Food Canada, Environment Canada, industry, and community organizations.
- All intensive fish culture operations, including: commercial grow-out sites, commercial hatcheries and broodstock programs, public and community enhancement hatcheries, and other relevant wild fish stock enhancement activities, should be subject to the policies of the Fish Health Working Committee.

Recommendation 16: Strengthen disease surveillance and control programs.

- The proposed Fish Health Working Committee should develop and implement active disease and disease-causing organism surveillance programs.
- First Nations fisheries staff, community fishers and salmon aquaculture industry staff should be trained to recognize various types of fish disease in order to assist with the surveillance. Protocols for data collection and sampling should be established.
- Using results of the active surveillance programs, the proposed Fish Health Working Committee should determine what diseases are of concern and are to be reportable under the *Animal Disease Control Act*.
- Until results of the active surveillance programs are available and sufficient to determine the diseases of concern (and thus to enable reportable diseases to be listed), operators should be required to acquire diagnosis from a recognized laboratory when the daily mortality rate (not due to predation or harmful algal blooms) is threefold larger than the mean daily mortality rate for the previous month, and report the results of the tests to the provincial Fish Health Veterinarian.
- Fish diseases should be identified by the proposed Fish Health Working Committee that are to be designated diseases under the provincial *Animal Disease Control Act*, to ensure that disease reporting requirements and other provisions become applicable to farmed fish, including the powers for inspectors to quarantine, seize and dispose of farmed fish based on the triggering of specific criteria. The proposed Fish Health Working Committee should regularly: review the reportable disease list, review and recommend the criteria, and make recommendations regarding effective quarantine and destruction of fish under legislation.
- Legislation should have a regulated cost recovery system that can be applied when intervention by government is necessary to cover costs to government of quarantining, seizing and/or disposing of farmed fish, and the existing cost recovery mechanisms under the *Animal Disease Control Act* should be reviewed by the committee for adequacy.

Recommendation 17: Develop standards for managing farmed salmon health as part of a salmon aquaculture code of practice, and enforce the standards as a condition of the salmon aquaculture licence.

- Enforceable standards for managing farmed salmon health should be developed as part of a salmon aquaculture code of practice, and should include standards respecting: disease prevention and management protocols, minimum health record requirements, outbreak management protocols, drug use, and disease reporting requirements.
- The provincial and federal governments should contribute to research into vaccine development.
- Initial standards should be in place within one year and apply to all new licences and licence renewals.
- The standards should be comprehensively and regularly reviewed for effectiveness after implementation by the proposed Fish Health Working Committee.
- The standards should apply to all intensive fish culture operations, including: commercial grow-out sites, commercial hatcheries and broodstock programs, public and community enhancement hatcheries, and other relevant wild fish stock enhancement activities.

Recommendation 18: Improve the quality and accessibility of fish health information.

- The provincial and federal governments should cooperate to develop a single, comprehensive fish health database which will store and link results of: field investigations and surveillance, inspections, monitoring, assessment, and reporting.
- Data from all intensive fish culture operations, including: commercial salmon grow-out facilities, private hatcheries and broodstock programs, and public and community enhancement hatcheries, should be integrated into the database.
- Mandatory published government reports on: the distribution and incidence of disease, pathogens and parasites in the waters of B.C., and at all intensive fish culture operations should be produced annually in a manner that protects proprietary information. The fish health database should be accessible and searchable, subject to screens on proprietary information, by the public through government staff on a cost recovery basis and accessible to First Nations on a government-to-government basis.

Recommendation 19: Strengthen policies and programs respecting importation.

- The 'surface-disinfected, fertilized egg only' policy for importations should continue to apply to all Atlantic and Pacific salmon imports originating from outside of B.C. Importation of live fish, unfertilized eggs or milt should be prohibited under all circumstances. Current policy respecting other importation practices should remain in place.
- A standard maximum number of allowable imported fertilized eggs per year for Atlantic and Pacific salmon should be established by the proposed Fish Health Working Committee, in cooperation with the Fish Transplant Committee, based on consideration of the minimum requirements for broodstock development and research. An equitable arrangement to allocate eggs among operators should be adopted, based on annual needs of individual operators.
- Importation policies should apply equitably to all intensive fish culture operations, including: commercial salmon grow-out facilities, private hatcheries and broodstock programs, and public and community enhancement hatcheries.
- The proposed Fish Health Working Committee should review the schedule of sampling and reporting requirements for disease, pathogens and parasites related to a transfer event, to ensure that the program is adequate, appropriate and transparent. The proposed Fish Health Working Committee should work closely with the Federal-Provincial Fish Transplant Committee to review and suggest criteria which must be satisfied and health information which must be made available before fertilized eggs can be considered for importation into the province. Respective roles concerning importations should be resolved. Within one year of operation, the proposed Fish Health Working Committee should make recommendations on the frequency and nature of sampling for monitoring and reporting of the health status of fish related to an importation event.
- All diseases, pathogens and parasites that are foreign to B.C., or are only known to exist in distinct regions within the province, should be made reportable. The proposed Fish Health Working Committee should create a list of reportable diseases and update it annually, as a basis for listing reportable diseases under the *Animal Disease Control Act*.
- Sampling or reporting should be standardized, irrespective of the origin of, or destination for, the importation, until the level of scientific knowledge is sufficient to appropriately adjust protocols to determine if variable standards are justified based on risk assessment.
- The proposed Fish Health Working Committee should proactively develop for management agencies, a recommended response to diseases and disease-causing agents which are detected or diagnosed, and are previously unrecognized in B.C.

Recommendation 20: Strengthen the requirements for sampling and reporting of diseases in fish being transferred within B.C.

- The proposed Fish Health Working Committee should review the schedule of sampling and reporting requirements for diseases, pathogens and parasites related to a transfer event to ensure the program is adequate, appropriate and transparent. The committee should work closely with the Federal-Provincial Fish Transplant Committee to review and suggest criteria which must be satisfied and health information which must be made available before fish can be considered for transfer within the province. Respective agency roles concerning transfers within the province should be clarified.
- All diseases, pathogens and parasites that are foreign to B.C. or are only known to exist in distinct regions within the province should be reportable regardless of the nature of the transfer event. The list of diseases to be made reportable should be created by the Fish Health Working Committee, and updated periodically.
- Sampling or reporting should be standardized, irrespective of the origin of, or destination for, the transfer, until the level of scientific knowledge is sufficient to appropriately adjust protocols to determine if variable standards are justified based on risk assessment.

Recommendation 21: Enhance fish health inspection practices at fish processing facilities.

- Provincial and federal government agencies mandated with the protection of human health should review, and if necessary, enhance standards and protocols for post-slaughter fish inspection for diseases, pathogens and parasites. Criteria for determining sampling protocol and schedule should be transparent.
- Case-specific sampling should be determined by an inspector with use of an accredited laboratory, requiring periodic "unannounced" audits and validation of industry claims of drug use and withdrawal based on case information.
- Sampling should be increased from present levels to reduce sampling error to statistically acceptable levels.
- Costs of monitoring and auditing should shift to a cost recovery basis as provincial and federal governments' cost-recovery policy is implemented for other food industry sectors.
- Drug treatment records with farmed fish shipments to processing plants should be regularly reviewed by the proposed Fish Health Working Committee to identify trends and anticipate potential issues.
- Results of fish health inspections at processing facilities should be integrated into the Fish Health Database. Similarly, drug treatment records with shipments to plants should be integrated and data periodically audited.

Recommendation 22: Strengthen control of drug use on salmon farms.

- When drugs are being used on a net-cage site, visible flag indicators should be required to be used at all times and throughout the prescribed withdrawal period. Similarly, written notice of the specific drug being applied should be posted and visible from outside the tenure boundary.
- All drugs used on intensive fish culture operations should be under prescription by a veterinarian with appropriate expertise and experience in fish health.
- Drug use at salmon farms should be regularly evaluated by the proposed Fish Health Working Committee for changing patterns, with appropriate measures taken or analyses referred to management agencies.
- All information related to drug prescription and use on intensive fish culture operations should be integrated into the Fish Health Database.

Recommendation 23: MoH and Health Canada should undertake further review of issues related to antibiotic and other drug use at salmon farms.

- MoH and Health Canada should assess the risks associated with the potential for the increase of antimicrobial resistance arising from the use of antibiotics at salmon farms and determine appropriate course of action.
- MoH and Health Canada should undertake a preliminary review of the administration and regulation of antibiotics used in livestock species raised for human consumption, including farmed salmon, to determine whether further action is needed by federal and provincial Ministers of Health.
- Health Canada should consider whether the process used to approve drugs under the *Food and Drug Act* adequately addresses potential environmental impacts resulting from the administration of those drugs to farmed salmon and determine whether further action is needed.

Waste Discharges

Recommendation 24: Develop a regulation under the Waste Management Act that implements a Performance Based Waste Management Model

- The regulation should require:
- Management of the uneaten feed and fish faeces from salmon farms to avoid adverse effects to the environment and within the assimilative capacity of the environment over a stocking and grow-out cycle.
- Management of salmon feed and waste by measuring the environmental effects and managing farms to achieve the objective of operating within the assimilative capacity of the site over that period of time.
- Establishment of standards based on quantitative sediment parameters that are indicative of environmental conditions.
- No measurable adverse impact beyond the edge of the tenure.
- Standards to ensure that sediments under net-cages are not degraded and support levels of biological activity that ensure sediments will return to ambient or near ambient standards within a short period of time of removing fish from a site.
- Sediment standards return to ambient or near ambient conditions (some enrichment) prior to restocking a site with fish.
- The adoption of existing water quality and sediment standards for metals.
- Standard sampling protocols, including methods and frequency, for ongoing monitoring of the adopted performance standard.
- The development of a waste management plan for each farm site. The plan should outline the methods for handling farm materials in a manner that prevents pollution and for removing dead fish from the site for offsite treatment, and the operational practices by reference to the code of practice (see Chapter 15) for managing fish and fish feed to prevent adverse environmental effects. The current policy, "Environmental Management of Marine Fish Farms", July 1990, provides a basis for development.
- Inclusion in the waste management plan of a contingency plan for dealing with spills of all materials held on site, and remedial action or mitigation plans to alter farm practices or production, should performance standards not be met.
- Implementation of mitigation plans as directed, by the regional manager or at the end of a grow-out cycle, if the standards are not met.

Recommendation 25: In order to set benthic sediment standards, government should test criteria for establishing the standards to ensure feasibility and consistency with government policy.

- MELP should establish sampling program and protocols for testing criteria with biological, chemical and physical parameters to be monitored.
- MELP should establish reference sites that represent ambient conditions.
- Sampling and analysis should be conducted by qualified third-party specialists and submitted to MELP within 30 days of collection.

Recommendation 26: (Option to Recommendation 25)

- Adopt the performance-based sediment monitoring programs of New Brunswick if MELP is unable to develop standards within 18 months of this report

Recommendation 27: Apply existing regulatory scheme until performance based regulation enacted.

- Until a new regulation is enacted, apply the current regulatory framework.
- The monitoring program needed to test and establish benthic standards should be stipulated by the manager under the Aquaculture Waste Control Regulation, or alternatively, requested as information under that regulation.
- Farm owners should, in this period of time, develop waste management plans in consultation with MELP for existing sites.
- Consider making an interim amendment to the existing regulation exempting all farms from the requirement to hold a permit, provided that a waste management plan is adopted which the regional manager approves.

Recommendation 28: Establish registry of farms with prescribed fees under the new performance based regulation.

- A registry of farms should be established by the regulation recommended in #24 above. The regulation should require that the holder of a salmon aquaculture licence be required to file annually with MELP disclosing whether or not the site under licence will be operational during that year and if so for which months. An annual fee should be prescribed (\$100-\$300) which would cover the administrative costs of the registration and replace the fee currently paid under Schedule A of the Waste Management Permit Fees Regulation.
- Schedule C of the regulation should be made applicable to all farms and fees should be recovered for the contaminants listed by that regulation that are discharged to the environment (ammonia, nitrogen/nitrates, phosphates, suspended solids, metal, antibiotics). If the farmer can demonstrate that these contaminants are not being discharged to the environment due to the implementation of new technology, the fees would not be payable.
- Fees should be payable at the end of each year, based on the amount of feed used on a farm, which would also provide a basis for the calculation of the contaminants discharged.
- The operator should be required to keep records of feed usage which would be subject to audit.

Recommendation 29: Develop regulatory provisions to ensure consistent enforcement and audit systems.

- Farmers, as stewards of the resources under tenure, should be monitoring their sites more frequently than required by MELP, to ensure that wastes are being managed and to make appropriate husbandry adjustments as necessary to ensure compliance.
- The new regulation should require the farm operator to prepare a mitigation strategy or remedial action plan approved by MELP, for a full grow-out cycle. If standards are exceeded, the plan would outline steps to be taken, including changes to husbandry practices, moving net-cages within tenures and moving some or all of the stock from the tenure.
- Monitoring data and reports required by MELP should be routinely assessed and periodically audited. The regulatory framework should establish disciplinary policies which provide steps to be taken when standards are not met. MELP should consider the following as part of that disciplinary policy:
 - advise the operator of the apparent problem,
 - undertake analysis to reassess data; if the problem is confirmed, advise the farmer to implement the mitigation plan if not yet implemented,
 - ensure the regional manager considers whether or not to issue a pollution abatement order and/or a pollution prevention order depending on the circumstances,
 - reassess after implementation of mitigation plan, and
 - implement appropriate punitive action for non-compliance.
- Steps should be taken to have fines imposed as ticket information offences.

Recommendation 30: On a priority basis, examine measurements of existing benthic conditions below sites and remediate existing sites where conditions of degradation are visible.

- On the basis of existing data, MELP, in cooperation with MAFF and all farmers, should identify sites with significant adverse benthic impacts.
- At the identified sites, farmers, in consultation with MELP, should develop for MELP's approval, plans to improve the benthic conditions.

Recommendation 31: Undertake focused research projects that assess the impacts of salmon farming on shellfish and other wild fishery resources on a priority basis.

- MOH, Health Canada, MELP and MAFF, in consultation with First Nations, DFO and Environment Canada, should develop a program to assess potential impacts of salmon farming on shellfish and other fishery resources, especially with respect to:
 - antibiotics used at farms; including the dispersion of antibiotics into the water column, the uptake of antibiotics by adjacent shellfish resources, and the impacts on other mobile organisms,
 - suspended solids emanating from farms, including an assessment of siltation and suspended solids levels in waters adjacent to salmon farms and impacts on adjacent resources, if levels are found to be above ambient, and
 - quality, taste, growth, and mortality rates of shellfish in the vicinity of farms.
- Salmon farmers should:
 - involve First Nations in research and analysis,
 - determine if a turbidity standard is needed for water quality based on the outcome of the assessment,
 - disclose and discuss the results of these studies with First Nations and other coastal users directly reliant on the resource and make results of studies available to coastal resource users through publication, and
 - review TAT recommended siting standards regarding distances from shellfish resources on the basis of results of these assessments and change the standard adopted in Chapter 4 if indicated by the results.

Recommendation 32: Review existing policy prohibiting polyculture.

- MAFF, MELP and DFO in consultation with Environment Canada should review the policy regarding monoculture with a view to determining whether or not polyculture could be practical.

Recommendation 33: Incorporate results of monitoring and research into MAFF site assessment model

- Once performance standards have been set, upgrade the MAFF site assessment model to improve predictive capability, taking into account sediment characteristics, flow and water currents information acquired during the standards establishment and research studies.
- If possible, incorporate the results of the assessment of the siltation and pharmacokinetics of antibiotics into the siting model as a means of better site selection.

Interactions with Coastal Mammals and Other Species

Recommendation 34: Implement enforceable predation prevention plans at all salmon farms.

- Government should require all salmon farms to develop and implement a "predation prevention plan" that identifies the specific predator net systems or other physical barriers to predators that will be used at the farm site to prevent predator problems.
- Predation prevention plans should be incorporated as enforceable requirements of the aquaculture licence.
- Government agencies should, in consultation with industry, prepare and maintain up-to-date guidelines describing best available anti-predation net systems and other technologies, and appropriate husbandry practices, to assist operators in preparing effective predation prevention plans.
- Predation prevention plans should be developed and in force at all salmon farms in B.C. within two years. This time frame may be shortened and expectations respecting predation prevention plans may be varied, pending the potential adoption of alternative technologies such as closed marine systems which would significantly reduce predator interactions (see Recommendation 43).

Recommendation 35: Strictly control the killing of predators at farm sites.

- Government should permit killing of predators (mammals and birds) at farm sites only if the predator is inside the predator or growing nets and is actively attacking farmed fish, or is about to do so.
- Government should require under the permit (federal and provincial) that persons undertaking the shooting have completed the provincial fire arm safety course.
- Government should require that all predator kills be recovered, recorded and reported to the appropriate government staff (i.e., provincial conservation officer or DFO fisheries officer, as appropriate).
- Where a farm is having ongoing problems with persistent predators, government should encourage operators to contact the local provincial conservation officer or DFO fisheries officer (as appropriate) who may, at their discretion, trap or kill individual predators; and who may recommend that changes be made to the farm's predation prevention plan to make it more effective.
- Government staff should keep records of all predator kills at farm sites as a basis for monitoring the effectiveness of individual predation prevention plans, and for incorporating changes to such plans, as warranted.

Recommendation 36: Discontinue the use of acoustic deterrent devices (ADDs) at B.C. salmon farms.

- Government should phase out the use of all existing ADDs over a two-year period to coincide with the development and implementation of "predation prevention plans" at each salmon farm. As this is a recommendation that impacts DFO, active consultation between MAFF and DFO will be necessary to develop a joint approach to this recommendation.
- Approved predation prevention plans should prohibit the use of ADDs.
- Federal and provincial agencies should actively monitor the effectiveness of this recommendation on predation levels and impacts, to determine if discontinuance of ADDs in favour of physical prevention systems successfully addresses the predation issue, and to determine if there is an effect on the rate of shooting of predators.

Recommendation 37: Restrict the practice of "night lighting", pending

- the results of further research.
- Government should restrict the practice of "night lighting" (i.e., photo period manipulation) to those existing farms that are approved to conduct this activity.
- Government should not issue any new approvals for "night lighting" at fish culture operations, pending the conclusion of additional scientific research into the effects of this practice on local biota. This should be undertaken on a priority basis.
- On the basis of study results, government should determine if their use should be continued or stopped.

First Nations Issues

Recommendation 38: Develop strategies to address First Nations concerns about siting of salmon farms.

- Government should develop and implement regional strategies to deal with renewal of tenures prior to issuing new tenures, to ensure compliance with the Crown Lands Activities Policy of avoiding unjustifiable infringement of aboriginal rights.
- Government should integrate strategies for regional review of tenured sites with further assessment of sites for waste impacts and with regional and coastal planning exercises.
- Government should offer First Nations representation on the Fish Farm Review Committees and ensure that direct First Nations consultation is carried out in the appropriate manner consistent with the Crown Lands Activities Policy and existing interim measures agreements or protocols for new tenures, renewals and amendments.
- Consultation and decision-making should be consistent with the principles outlined in Chapter 9 and Volume 2 of this report.

Recommendation 39: Develop strategies to involve First Nations in policy development, and research management.

- Government should ensure representation of First Nations on organizations established to provide policy advice to government regarding salmon farming.
- Government should encourage the employment of local people, including First Nations, by the salmon farming and support industries. A staffing and hiring plan should be submitted as part of the proposal with the tenure application at the time of tenure review.
- Government should identify the training needs necessary to ensure First Nations have technical capability to provide scientific monitoring services directly to industry or to government and should develop a strategy to access resources for implementing the training programs necessary to address those needs.
- Industry, MAFF and MELP should rely on the services of First Nations to assist with providing environmental monitoring and audit services.
- Government should provide training programs regarding fish health, fish disease identification and disease management to interested First Nations.
- Government should develop a strategy to provide access to the fish health database (to be developed following implementation of recommendations in Chapter 6) to interested First Nations.
- Government should involve First Nations (as under the KTFC MOU) in the development of research proposals and in priority research into the potential impacts of salmon farms on local seafood resources, especially with respect to antibiotics used on farms (as outlined in Chapter 6), and potential impacts of the use of lights on farms.
- Government should involve interested First Nations directly in development and implementation of pilot programs for closed marine technologies (discussed in Chapter 11).
- Government should assist interested First Nations in developing strategies to participate directly in the salmon farming industry.

Managing Risk and Uncertainty

Recommendation 40: Undertake coordinated scientific research, technological trials and inventory investigations, based on the prioritization of initiatives.

- The government should implement the research-related initiatives in the time frame shown in Table 17 as a means of addressing uncertainty and applying adaptive management principles.
- Government should ensure equitable sharing of costs by industry (also refer to Recommendation 44).

Recommendation 41: Reduce risk through performance based program implementation supported by comprehensive monitoring.

Alternative Salmon Farming Technology

Recommendation 42: Undertake further analysis and development of the policy framework necessary for exposed offshore open marine systems.

- Federal and provincial governments should clarify jurisdiction and the policy and management regime for potential exposed offshore open marine salmon aquaculture facilities.
- The social and economic considerations, especially with respect to worker safety, navigational safety, and the potential for jobs relating to the handling and processing of the product moving away from smaller communities, should be assessed, following which government should establish a clear policy on whether or not it will support such facilities off the coast of B.C.

Recommendation 43: Initiate pilot projects to assess the development of closed circulating marine systems in B.C.

- Pilot projects should be initiated to allow for direct assessment and encouragement of closed marine systems in B.C. Both the "Future Sea Farms" and "Mariculture" systems should be tested in a variety of habitat types and siting conditions on the west coast of Vancouver Island and in the Broughton Archipelago. Monitoring data from the Future Sea Farms test site near Nanaimo should be considered in this assessment.
- MAFF and MELP should cooperate to establish a task force of industry, provincial and federal governments, First Nations, and interested local governments to select sites and develop strategies to implement pilot projects through cooperative arrangements with these groups.
- Costs for the pilot projects should be covered through harvesting of the product, and direct investments from government and industry.
- The strategies developed should provide opportunities for First Nations and local community members with appropriate technical expertise to direct or participate in operating, monitoring and evaluating the technologies.
- Reports on evaluations should be documented and accessible to the public.

Recommendation 44: Establish a funding commitment to salmon aquaculture research and development.

- The Ministry of Agriculture, Fisheries and Food should work with the industry to establish an industry-sourced research and development fund, whether through the industry association or under the *Farming and Fishing Industries Development Act*, or through some other mechanism, to make funding available for research and technological development (also see recommendation 40).

Dispute Avoidance and Resolution

Recommendation 45: Establish improved mechanisms for addressing disputes that arise over salmon aquaculture.

- Government agencies should establish and implement a comprehensive approach to preventing and responding to disputes that arise in connection with salmon farm tenuring, operational licensing decisions, and operational practices at farm sites. The dispute resolution 'system' for salmon aquaculture should consist of the following features:

Dispute Prevention

- Emphasis should be on dispute prevention through a range of proactive means, including improved inter-agency coordination, integrated coastal zone planning, adoption of refined siting criteria, strengthened public and First Nations participation in siting decision-making, and improvements to resource inventories and mapping as the technical basis for siting and management decisions (see siting-related recommendations in Chapter 4). Involvement of all levels of government and interested agencies in a policy advisory capacity will, at a broader level, serve to address issues which are the basis for many disputes.

Public Notice

- Licensing agencies should establish procedures and mechanisms that consistently inform the public of the status of site tenuring and operations-related licensing/permitting applications, and allow an appropriate period for public comment, as a further basis for dispute prevention.
- With respect to site tenure, there should be a policy requirement for salmon farming proponents to sponsor one or more local open houses to explain their proposals and receive comment, and/or to meet with local advisory working committees to discuss their proposals. To facilitate the public notice objective, MAFF should develop and maintain an internet web site that lists all salmon farming-related regulatory applications and describes the current status of those applications.
- The procedural right of any party to register a formal objection to a site application with the Minister of Environment, Lands and Parks should be made known through all feasible means (e.g., on the proposed internet website and, in newspaper notices of pending applications).

Internal Review Procedures

- All licensing agencies (MAFF, MELP, DFO) should develop and implement written administrative procedures to be followed in providing written reasons for decisions, addressing queries, complaints and concerns from applicants and the public about licensing decisions that are made by those agencies. The procedures should stress timeliness in responding to queries.

Opportunity to File Complaints about Salmon Farming Practices

- Complaints about operational practices at individual farm sites should be handled under the procedures recently set up under the provincial *Farm Practices (Right to Farm) Act*, where complaints may be addressed informally by regional MAFF staff and "peer advisors", or referred to the provincial Farm Practices Board for review and decision.
- Policy Context and Advice

Recommendation 46: Develop and adopt a set of integrated, strategic policy objectives for salmon aquaculture in B.C.

- The provincial government should implement its plan to prepare a statement of its corporate policy direction for salmon aquaculture in B.C., identifying specific environmental, economic and social policy objectives for this sector.
- The strategic policy objectives should serve as a basis for the development and implementation of more specific salmon aquaculture regulations, programs, policies and guidelines; and provide essential strategic direction for coastal zone planning processes.
- The strategic policy objectives should be developed through inter-agency and inter-governmental cooperation, and with the participation of all key governments and groups with an interest in salmon aquaculture in B.C.
- The objectives of the fisheries renewal program should be a consideration in this policy development.

Recommendation 47: Re-establish a broadly based advisory group to provide counsel to government on the management of salmon aquaculture in B.C.

- An advisory group comprising representatives of all key interests should be re-established to provide advice to the provincial government on development and implementation of the provincial salmon aquaculture management system, monitor policy implementation, advise on research priorities, and serve as a forum for dialogue and information exchange among the interests.
- The advisory group should regularly report to both the Minister of Environment, Lands and Parks and the Minister of Agriculture, Fisheries and Food as the two Ministers with mandates that relate most directly to salmon aquaculture management, and report annually on the progress of implementation of these recommendations. The group should interact with representatives of all key agencies to ensure that the advice that the group provides to the Ministers integrates the range of policy positions and priorities of the agencies.
- The advisory group should also report to the Ministers of Health, Small Business, Tourism and Culture, Aboriginal Affairs, and Employment and Investment as appropriate on issues of direct concern to their mandate.
- The government should consider using the Fisheries Renewal Board or a related committee as the policy advisory group.

Implementation

Recommendation 48: On a priority basis, develop a comprehensive code of salmon aquaculture practice.

- Develop a comprehensive code of salmon aquaculture practices that would, in a single reference document:
 - identify all the requirements associated with the development and operation of salmon farms in B.C.,
 - provide guidance about optimum husbandry practices and procedures to maintain the best salmon farming practices, and
 - set monitoring requirements and protocols.
- The document should be developed cooperatively by government, industry and other key interests, but maintained by government, and structured to include separate sections on:
 - escape and prevention management,
 - fish health management,
 - waste management including remedial action plans,
 - predation management,
 - noise and visual impact management,
- Salmon farmers should use this document as a source in the development of their farm-specific salmon aquaculture management plans, which would identify the measures to be used at the farm to prevent or mitigate escape, fish health, waste, predation, and other issues.
- The code should:
 - describe the processes for applying for tenures, operating licences and other necessary approvals, and
 - outline methods for addressing complaints and solving disputes related to salmon farm practices.

Recommendation 49: Government should implement changes to the legislative, regulatory and policy framework for provincial approval processes as summarized below (some of these recommendations have been made previously in this report).

Legislation

- Amend the *Fisheries Act* (B.C.), or develop new legislation to reflect broadened policy base for salmon aquaculture.
- Enact orders under the *Animal Disease Control Act* to make it applicable to fish diseases.
- Amend *Animal Disease Control Act* as necessary to expand capability to cost recover for government implemented disease control measures.
- Consider the future development of legislation for coastal zone planning.

Code of Practice

- Develop in accordance with Recommendation 48.

Regulations

- Amend Aquaculture Regulation to establish expanded standardized operational requirements.
- Consider amending the Aquaculture Waste Control Regulation to eliminate need for permits for some farms and impose requirement of waste management plan on all farms.
- Develop new waste management regulation by April, 1999.
- Amend Animal Disease Control Regulation as necessary, to respond to recommendations of the Fish Farm Review Committee

Licences

- Develop new format for aquaculture licence based on amended Aquaculture Regulation.
- For new aquaculture licences, impose the detailed operational standards as terms and conditions.
- Impose restrictions on the medicated feed dispensers/vendors through the licence to ensure policy of providing medicated feed only under veterinarian prescription.

Policies and Agreements

- Develop operational policies to implement recommendations, in particular:
 - adopt the tenure review process outlined in Figure 11 and develop assessment criteria for tenure applications that provide an approach to considering relevant environmental and social factors associated with the tenure application, and
 - adopt the licence review process outlined in Figure 15,
 - develop an enforcement and compliance policy and manual, and
 - provide policy guidelines to establish the Fish Farm Review Committee.
- Review and amend federal/provincial MOUs as necessary.

CHAPTER 1. INTRODUCTION

I. THE SALMON AQUACULTURE DEBATE

The physical and geographic characteristics of parts of B.C.'s coastline make it suitable for salmon aquaculture. The industry emerged in B.C. in the early 1970s with the first farms established along the province's southern coastline. The industry grew slowly until the mid 1980s and then rapidly during the latter half of the decade until in 1988 there were 101 salmon farming companies operating in B.C. Between 1989 and 1992 about one-quarter of the B.C. industry went into receivership due to a drop in salmon prices, financial instability of a number of farms, and the location of some farms at environmentally unsuitable sites. This same period saw the consolidation of smaller farms among fewer companies and the beginning of a trend towards farm relocation to colder and better flushed coastal waters on Vancouver Island's north and west coasts. At present, 16 salmon farming companies operate 79 active salmon farm grow-out sites in B.C. The total annual production of B.C. farmed salmon in 1996 was 25,500 tonnes.

Corresponding with the period of rapid industry growth in the 1980s, there were escalating public concerns about the industry's impacts on the environment and other coastal users. The B.C. government responded in 1986 by placing a moratorium on the approval of new salmon farms and launching a public inquiry (the "Gillespie Inquiry"¹) into the issues. The inquiry produced numerous recommendations on a range of topics including: protection of the marine environment, First Nations involvement in decision-making, government approval systems, resolving user and siting conflicts, and marketing and approval systems. The province acted on most of the recommendations and, in stages, lifted the moratorium on new salmon farm approvals. One significant outcome of the inquiry was a program to prepare Coastal Resource Interest Studies (CRIS) in regions experiencing significant salmon aquaculture conflict among coastal resource users. These planning initiatives have been used by regulators to guide salmon aquaculture siting decisions.

Another outcome of the Gillespie inquiry was the creation of a "Minister's Aquaculture Industry Advisory Committee" (MAIAC), comprising various stakeholder representatives with a mandate to advise the Minister of Agriculture, Fisheries and Food on means to ensure the orderly and responsible development of aquaculture in British Columbia. This committee operated until 1993.

In 1988, the provincial Office of the Ombudsman produced a special report on aquaculture and the administration of coastal resources in B.C.² The Ombudsman investigation was initiated in response to numerous complaints about the salmon aquaculture site tenure granting process, environmental safety, and conflict with other coastal users. The report dealt with measures for introducing principles of administrative fairness into salmon aquaculture management. A program

of integrated coastal zone planning, adoption of a clear regulatory basis for salmon aquaculture, and use of consensual dispute resolution techniques were the Ombudsman's prime recommendations. The major government response to the Ombudsman's recommendations was adoption of a regulatory requirement for salmon aquaculture facilities to obtain (in addition to the routine site tenure requirement³) an aquaculture licence⁴ which provided a standardized legal basis for regulating operational practices at salmon farms.

Also in 1988 the federal Standing Committee on Fisheries and Oceans released a report⁵ on Canadian aquaculture which resulted in the creation of a Department of Fisheries and Oceans aquaculture coordinator for B.C., and adoption of a federal-provincial memorandum of understanding respecting roles and responsibilities for managing salmon aquaculture in B.C.

Although policies and administrative systems for managing salmon aquaculture in B.C. improved substantially as a result of government responses to the Gillespie inquiry, the Ombudsman's review and the federal standing committee report, numerous issues and strong public concerns about the industry persisted. In 1992, MAIAC was asked by the Minister of Agriculture, Fisheries and Food to make recommendations on the need for further research, policy clarification and regulatory change respecting the industry. The Committee made a number of recommendations for addressing environmental and social and administrative issues in 1993. Government's response to those recommendations included an assessment of interactions between wild and farm fish and the development of a Memorandum Of Understanding (MOU) between the Province and the Kwakiutl Territorial Fisheries Commission (KTFC) regarding management of aquaculture and aquatic resources in the Johnstone Strait area.

Ongoing environmental concerns raised by the Ministry of Environment, Lands and Parks (MELP), environmental organizations, fishers and the public, prompted government in 1995 to announce an "Action Plan for Provincial Salmon Aquaculture." The Action Plan was formulated through meetings between provincial agencies and key interests to discuss the issues. It identified the need to undertake a definitive environmental review of salmon farming activities and, based on the findings of that review, to comprehensively examine the provincial salmon aquaculture policy with a view towards adopting appropriate policy development and reforms. This report represents the review of the technical issues requested as a basis for that policy development.

The decision to conduct yet another environmental and policy review of B.C.'s salmon aquaculture management system is explained by the relatively recent arrival of the salmon aquaculture industry in B.C. and the continuing uncertainty about potential environmental risks of salmon aquaculture. The decision may also indicate a failure of past initiatives and reforms to adequately address public concerns, a weakness in the assessment of the effectiveness of measures that have been implemented, and/or a failure in communicating the implementation strategies.

II. THE ROLE OF THE ENVIRONMENTAL ASSESSMENT OFFICE

The task of performing the environmental review was assigned to the provincial Environmental Assessment Office (EAO), an agency with no relationship to, or investment in, the development or implementation of B.C.'s salmon aquaculture policy.

The EAO was created in 1994 through adoption of the provincial *Environmental Assessment Act* (EAA).

Although the EAO is primarily concerned with coordinating environmental impact assessments for individual, site-specific commercial, manufacturing and industrial projects, section 40 of the Act provides the EAO with powers to perform assessments of the effectiveness of other enactments for preventing or reducing adverse effects of activities that are regulated by those enactments.

40. (1) The Minister and the Minister charged with the administration of another enactment jointly may direct the Executive Director, in accordance with terms of reference specified by the Ministers, to examine
- (a) the methods in use under the other enactment for the prevention or reduction of adverse effects of projects that are the subjects of applications for approvals under the other enactment, and
 - (b) any other processes, practices and procedures in use under the other enactment that are pertinent to decisions under it in relation to applications for approvals and the renewal, amendment, cancellation and suspension of approvals.
- (2) The Executive Director must report the results of an examination under subsection (1) to the Minister and the Minister charged with the administration of the other enactment, including the report recommendations, consistent with the purposes of this Act, for improvements in
- (a) the processes, practices and procedures examined by the Executive Director, and
 - (b) the methods in use under the other enactment for the prevention or mitigation of adverse effects.
- (3) After receipt of the report of the Executive Director under subsection (2), and after taking into account the recommendations contained in the report, the Minister charged with the administration of the other enactment, acting with the concurrence of the Minister, may issue guidelines, to be followed by the employees and agents of the ministry administering the other enactment, respecting
- (a) the processes, practices and procedures under the other enactment in relation to applications for approvals and the renewal, amendment, cancellation and suspension of approvals, or

(b) the methods in use under the other enactment for the prevention or mitigation of adverse effects.

(4) The guidelines referred to in subsection (3) must be consistent, in the opinion of the Minister and the Minister charged with the administration of the other enactment, with this Act and with the other enactment to which the Executive Director's report under this section pertains.

Where the EAO has been asked by provincial ministers to perform a review of this nature, the EAO Executive Director is required by section 40(2) to report the results of the examination and make recommendations to the ministers for improving existing measures for preventing or mitigating adverse effects. The recommendations must be consistent with the express purposes of the EAA, which include promotion of "sustainability by protecting the environment and fostering a sound economy and social well-being."⁷ The Salmon Aquaculture Review (SAR) is the first section 40 assessment performed by the provincial EAO.

III. SALMON AQUACULTURE REVIEW PROCESS

A. Background

In July 1995 the Minister of Environment, Lands and Parks and the Minister of Agriculture, Fisheries and Food asked the EAO to conduct a review of the adequacy of current methods and processes used by the two ministries in reviewing and adjudicating salmon aquaculture applications and regulating ongoing salmon aquaculture operations. In November 1995, the direction to begin the review was given along with a request to provide a socio-economic context and an evaluation of results to Ministers. The terms of reference did not direct an assessment of human health effects, but in providing the socio-economic context, and in assessing the issues which have associated human health aspects, these issues were raised. The specific objectives of the SAR are described in the terms of reference provided by the Ministers, as contained in Appendix 1, Section 3.2.

Between November 1995 and January 1996 the EAO broadly circulated a draft SAR terms of reference to the interested public, salmon aquaculture industry, interest groups, First Nations, local government and provincial and federal agencies to obtain input on the specific issues that should be investigated and the methodology for conducting the SAR.⁸ Over 250 responses led the EAO to recommend to the Ministers some minor clarifications and adjustments to the SAR process scope and structure. These recommendations were approved by the Ministers, and in April 1996 the EAO released a document that summarized public comments and confirmed the terms of reference⁹ with direction on an approach to issues. The finalized SAR terms of reference confirmed that the environmental review should focus on the key issues of:

- potential impacts of escaped farm salmon,
- farm and wild fish health,
- potential environmental impacts of salmon farm waste discharges,
- potential interactions between salmon farms and marine mammals and other species, and
- salmon farm siting concerns.

The revised terms of reference also confirmed that the SAR should incorporate socio-economic considerations into the review and should proceed using the review structures shown in Figure 1. The process had been modified somewhat in response to comments received.

Figure 1. Salmon Aquaculture Review Structures and Process

B. Process Structures and Roles

As shown in Figure 1, the SAR process was based on two key components, a Technical Advisory Team (TAT) and a Review Committee (RC). The purpose of the TAT was to provide objective technically based information for the review. Individuals were nominated to serve as members of the TAT based on their interest in the subject and their professional qualifications. The TAT members chosen represented a range of academic backgrounds and skills, including a:

- fisheries biologist,
- fish culturist and physiologist,
- veterinarian and epidemiologist,
- architectural and environmental planner,
- **marine ecologist, and**
- mammalian specialist.

The EAO filed summaries of their qualifications on the publicly accessible project registry and consulted with selected review participants before retaining the members. TAT members were responsible for developing discussion papers on each of the five key SAR issues and making recommendations to the EAO for addressing the issues. Certain TAT members worked together on specific issues as co-authors and all members worked to provide each other critical comment and advice on their evolving work.

The purpose of the RC was to provide advice and critical comment on the information and recommendations of the TAT, to make submissions about salmon farming to the review and to convey information about the substance and stage of the review to those they represent. As with the TAT, proposed RC members were nominated to the EAO and selected on the basis of representing a sector identified by the EAO and being representative of an organization with members, so that information would both be received from, and disseminated to, the constituency through the member. The EAO became involved with the selection process only when a category was “over nominated,” as in the case of local governments and environmentalists, to attempt to keep the RC to a manageable size.

The RC, comprising voluntary representatives, were from a wide range of interested parties including local governments, First Nations, provincial and federal agencies, environmental and recreational organizations, commercial fishers, industry and industry-support service groups, to ensure that the TAT discussion papers were fully informed.

TAT members and their specific contributions to the review, as well as additional technical experts and their responsibilities, are listed in Appendix 2. The RC terms of reference and membership are provided in Appendix 3. First Nations participated in the SAR through direct membership on the RC in addition to having the opportunity to meet independently as a caucus with the TAT and to submit a separate technical paper to the SAR on First Nations perspectives on salmon aquaculture issues. Their submissions and perspectives on salmon farming are found in Volume 2 of this report. First Nations participation was coordinated by the B.C. Aboriginal Fisheries Commission. See Chapter 9 and Volume 2 for further information on the role of First Nations in the SAR.

C. Public Participation

In addition to the broad range of representation of the RC, members of the public were invited to make submissions orally and in writing to the review and to comment on TAT documents. Notice of working sessions was provided through direct distribution, the press and the internet. Many documents generated through the EAO by the TAT and the finalized notes of working sessions were posted on the internet (<http://www.eao.gov.bc.ca>) to facilitate public access to the SAR proceedings. All SAR materials were made available in “hard copy” at eight satellite repositories (listed in Appendix 3) mainly located in public libraries on Vancouver Island but also including the Vancouver Public Library. Members of the public in the study area were encouraged to provide direct observational information to the review (refer to “Study Area” section below).

D. Working Sessions

In the spring and summer of 1996, EAO representatives contacted individuals and groups that had been nominated through the SAR terms of reference development process to determine their interest and capacity to participate as members of the RC. Also during that period, TAT members were contacted to commence work on the technical discussion papers, and a comprehensive bibliography on salmon aquaculture (see Volume 5) was compiled by the EAO to support the TAT investigations.

Eight working sessions of the RC were held between September 1996 and April 1997, as summarized in Table 1. The Review Committee Terms of Reference and Operating Procedures were developed at the first working session (refer to Appendix 3). Issues were discussed and successive drafts of TAT discussion papers were reviewed during these sessions. The working sessions were open to the public and opportunity was provided at most working sessions for the general public to make comments or to present written submissions.

E. Submissions

The SAR benefited from over 85 written submissions from public and RC members. All written submissions were provided to TAT members for consideration in developing their technical discussion papers. A listing of the individuals and organizations that made written submissions to the SAR is shown in Appendix 4 together with a summary of RC comments on TAT recommendations. Documents that were generated as part of the SAR, including submissions from the public and RC members, draft TAT discussion papers, other technical reports and key correspondence, were filed on the EAO Project Registry, placed in satellite repositories, and loaded onto the EAO internet web site, in efforts to facilitate public access to SAR proceedings.

Table 1. Salmon Aquaculture Review Working Sessions

Meeting Dates	Location	Primary Objectives
September 13 and 14, 1996 reference and workplan	Campbell River	<ul style="list-style-type: none"> • introduction to review • review RC terms of
September 26 and 27, 1996 the status of coastal planning paper outlines	Port Hardy resource management and salmon aquaculture	<ul style="list-style-type: none"> • review TAT draft discussion paper outlines • obtain international perspective on coastal • share information on • review TAT draft discussion
October 18 and 19, 1996 support framework methodology overview of B.C. salmon aquaculture regulatory jurisdictional comparison	Campbell River	<ul style="list-style-type: none"> • field trip: farmed salmon processing and • review socio-economic • status reports on TAT discussion paper progress • framework and inter-
November 6,7 and 8, 1996 and RC submissions	Tofino	<ul style="list-style-type: none"> • TAT/First Nations working session • hear public
November 29 and 30, 1996 and RC submissions	Port Hardy (Fort Rupert)	<ul style="list-style-type: none"> • field trip: Broughton Archipelago • hear public
December 13 and 14, 1996 draft discussion papers	Nanaimo	<ul style="list-style-type: none"> • review TAT draft discussion papers • hear public and RC submissions • review TAT
January 16, 17 and 18, 1997 submissions	Campbell River	<ul style="list-style-type: none"> • TAT/First Nations working session • hear RC
April 2, 3 and 4, 1997	salmon aquaculture Nanaimo review management framework options and	<ul style="list-style-type: none"> • review draft socio-economic impacts of • review TAT draft discussion papers • review TAT major findings and recommendations • implications

F. Study Area

The Broughton Archipelago (see Figure 2 and attachment) was employed as a study area to document and demonstrate the SAR issues. A one-day field trip to the study area was organized to allow the RC to tour a salmon hatchery facility, visit an operating salmon farm, and observe siting-related issues at other locations in the study area.10 Additionally, public open houses were held in the study area to solicit anecdotal information respecting salmon aquaculture operations in the study area. Open house information results were documented and supplied to the TAT for their consideration. At the invitation of First Nations, representatives from the EAO and the TAT visited sites in the study area and in Clayoquot Sound with First Nations, to specifically look at local issues of concern, including the potential impacts of salmon aquaculture on First Nations shellfish food resources.

Figure 2. Broughton Archipelago Study Area

G. Evaluation and Reporting

Upon completion of working sessions of the RC, the TAT finalized their technical discussion papers and their recommendations for preventing or mitigating potential adverse environmental impacts of salmon aquaculture, and submitted them to the EAO in April/May 1997 (see Volume 3).

The TAT discussion papers were subjected to expert review at several stages throughout their development. Various drafts of the discussion papers were presented to the RC for review and comment. Similarly, drafts of the discussion papers were also circulated by members of the TAT to selected colleagues with expertise in the specific issue areas. The comments received by the expert reviewers and the RC were addressed by the TAT and incorporated into their final papers. The TAT recommendations were based upon a full review of all available literature and research, as well as comments received from expert reviewers, the RC, and members of the public. During April to June, 1997, the EAO evaluated economic, social and administrative implications of the TAT recommendations. In particular, the TAT's recommended siting criteria were investigated to assess the potential level of impact on B.C.'s salmon aquaculture industry. In addition, the EAO examined the feasibility of alternative salmon aquaculture technologies, including land-based and closed containment systems.

Based on these technical evaluations and also on the EAO's mandated requirement to simultaneously promote the environmental, economic and social dimensions of sustainability, the EAO assembled this final report for submission to the Minister of Environment, Lands and Parks and the Minister of Agriculture, Fisheries and Food. In accordance with section 40 of the *Environmental Assessment Act*, this report describes the conclusions and recommendations of the EAO with regard to:

- methods employed under provincial enactments for the prevention or reduction of adverse effects of salmon aquaculture operations (mitigation methods), and
- processes, practices and procedures related to approvals of salmon aquaculture applications (approval processes).

Recommendations about the mitigation methods are made throughout this report, as are recommendations about approval processes. A summary of legislative, regulatory and policy guideline changes recommended for key approvals is provided in Chapter 15.

Chapter 2. The Salmon Aquaculture Industry¹

I. Global Context

Although the growth and importance of global aquaculture is not well documented, the contribution of aquaculture to world food supplies since the early 1980s is dramatic. Between 1984 and 1992 total world plant and animal aquaculture production increased by 86 per cent. The UN Food and Agriculture Organization projects that by 2010, aquaculture will provide about 35 per cent of the total world fish supply available for human consumption. World farmed salmon production, as one form of aquaculture, has shown a steady increase during this same period. As shown in Figure 3, salmon farms now produce about one-third of the world's total annual salmon harvest. World farmed salmon production increased by over 400,000 tonnes between 1988 and 1995.

Figure 3. World Production of Wild and Farmed Salmon, 1973-1995.

Source: FAO annual statistics

The biggest producers of farmed salmon are Norway, Chile and the United Kingdom, in that order. In 1995 the combined output of these three countries comprised 80 per cent of world production. By contrast, B.C.'s annual production for the same year was under 25 thousand tonnes, representing just over 4 per cent of global farmed salmon production. Table 2 shows world farmed salmon production in 1988 and 1995 and demonstrates the significant production increases that have occurred in that period, particularly in Norway and Chile. Atlantic salmon is the species most commonly farmed worldwide, due to market preferences and cost advantages.

Table 2. World Production of Farmed Salmon, 1988 and 1995

	1988 Production		1995 Production	
	'000 Tonnes	% Share	'000 Tonnes	% Share
<i>Norway</i>	<i>80.3</i>	<i>57.5</i>	<i>251.0</i>	<i>45.5</i>
<i>Chile</i>	<i>3.1</i>	<i>2.2</i>	<i>126.3</i>	<i>22.9</i>
<i>United Kingdom</i>	<i>17.6</i>	<i>12.6</i>	<i>65.0</i>	<i>11.8</i>
<i>British Columbia</i>	<i>6.6</i>	<i>4.7</i>	<i>23.8</i>	<i>4.3</i>
<i>Ireland</i>	<i>4.2</i>	<i>3.0</i>	<i>16.0</i>	<i>2.9</i>
<i>Eastern Canada</i>	<i>3.3</i>	<i>2.4</i>	<i>14.7</i>	<i>2.7</i>
<i>United States</i>	<i>2.0</i>	<i>1.4</i>	<i>14.7</i>	<i>2.7</i>
<i>Japan</i>	<i>14.1</i>	<i>10.1</i>	<i>14.1</i>	<i>2.5</i>
<i>Faeroe Islands</i>	<i>3.4</i>	<i>2.4</i>	<i>12.4</i>	<i>2.2</i>
<i>Other Countries</i>	<i>5.1</i>	<i>3.7</i>	<i>13.9</i>	<i>2.5</i>
<i>TOTAL:</i>	<i>139.7</i>	<i>100.0</i>	<i>551.9</i>	<i>100.0</i>

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

II. British Columbia's Industry

A. Size and Location

As indicated in Chapter 1, there are presently 16 salmon farming companies operating in B.C. at 79 active grow-out sites. This represents a substantial reduction in the number of companies in operation and sites farmed, compared to the mid-1980s. The industry consolidated through the early 1990s, resulting in fewer firms, larger-scale operations and a greater number of sites controlled by each firm. The average number of active sites per company is now just under five, more than double the 1991 number and more than quadruple the average number of sites reported in 1988 (see Table 3). There has been a moratorium on the issuance of new tenures since 1995, although in 1996, several tenures whose applications had been pending for some time were issued.

Table 3. Number of Salmon Farming Companies and Grow-Out Sites, 1988-1996

	1988	1991	1993	1996
<i>Number of Salmon Farming Companies</i>	101	<i>n.a.</i>	17	16
<i>Number of Active Grow-Out Sites</i>	118	<i>n.a.</i>	88*	79
<i>Average Number of Sites per Company</i>	1.16	2.27	5.18	4.94

n.a.—not available. *May include some fallow sites.

Sources: Price Waterhouse (1993); ARA (1994); Coopers & Lybrand (1997); and data from 3 non-B.C. Salmon Farmers' Association (BCSFA) companies.

While the number of companies has decreased, their average size has significantly increased, as shown in Table 4. The six largest salmon farming companies now account for over 70 per cent of B.C.'s total farmed production. Many of these companies are large multi-nationals, with farming and processing operations in other countries, notably Chile, Norway and the United States.

Although all salmon farming companies in B.C. are involved in growing-out salmon at marine farm sites, most are also involved in other aspects of the industry. There are currently two freshwater lakes (Georgie and Lois) in B.C. using net-cages for juvenile salmon rearing. Other operations include: operation of hatcheries, marine transport, processing facilities, and marketing and distribution. The activities that salmon farms do not undertake for themselves are contracted to other firms.

Table 4. Distribution of Salmon Farming Companies by Level of Production (% of total number companies)

<i>Production Level</i>	<i>1993</i>	<i>1996</i>
<i>Less than 500 tonnes</i>	<i>35.3</i>	<i>25.0</i>
<i>500—999 tonnes</i>	<i>23.5</i>	<i>18.7</i>
<i>1000—1999 tonnes</i>	<i>17.6</i>	<i>18.7</i>
<i>larger than 2000 tonnes</i>	<i>23.5</i>	<i>37.5</i>
<i>TOTAL:</i>	<i>100.0*</i>	<i>100.0</i>

*Does not add due to rounding.

Sources: ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies.

In addition to the greater concentration of activity by multi-site, multi-national farms, there has been a marked shift in the location of farms in B.C. Most noticeably there has been a trend away from the Sunshine Coast to other areas (see Table 5). The Sunshine Coast has proven to be less environmentally suitable for grow-out operations than other areas. The locations of existing salmon farm site tenures in B.C., including inactive tenures, are shown on Figure 4. Salmon farming sites are normally quite small in area, usually occupying less than 10 hectares. Under 200 hectares of aquatic Crown land is presently allocated for salmon aquaculture purposes, representing a very small proportion of B.C.'s total coastline.

**Table 5. Distribution of Active Grow-Out Sites by Regional District
(% of total number of active sites)**

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

Sources: ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies.

Figure 4. Location of Salmon Farm Site Tenures in British Columbia (1995).

Source: McKinnell et al. 1997.

B. Salmon Farming Operational Practices

B.C. salmon farming industry practices continue to evolve with experience and in response to new information, regulations, technologies, and markets. During the period of early development, coho and chinook salmon were generally reared. Following the mid-1980s, production was replaced largely with Atlantic salmon, given a combination of market preferences, lower mortality rates and the ability to grow fish in higher densities. By 1994, Atlantic salmon made up over 70 per cent of B.C.'s farm salmon product, with chinook salmon making up almost all of the remainder. Only small amounts of coho salmon continue to be produced. Table 6 shows B.C. farmed salmon by species.

Table 6. B.C. Farmed Salmon Production by Species (tonnes)

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

Sources: Kenney (1996); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies.

Although marine grow-out sites are perhaps the most visible part of salmon aquaculture, the industry also entails a number of other activities, encompassing the rearing of salmon under controlled conditions from the egg to the market (see Figure 5).

Figure 5. Stages of Aquaculture Development.

Eggs that are imported, collected from wild stock or from farm broodstock are incubated, hatched and then reared in freshwater in either land-based tanks or in net-cages in freshwater lakes. B.C. salmon farmers operate 11 private hatcheries, located mainly on Vancouver Island. Eggs are hatched over a three- to five-month period, during which they are stored in stacking or circular trays with fresh water running through them. Hatchery water is normally pumped from wells to ensure consistent quality and temperature and is often discharged to filtration beds rather than directly to streams in order to isolate the hatcheries from the aquatic environment. Once hatched, the young fish are transferred to land-based circular tanks or to net pens in lakes where they are held until they reach smolt stage.² During this period, young fish may be vaccinated as a precaution against future disease.

Once juvenile fish reach the smolt stage they are transferred to marine-based net-cages for grow-out. Cage culture, where fish are contained in open mesh nets that are suspended from anchored metal cage frames, is the only aquaculture system presently employed by commercial farms in B.C. marine areas.³ The advantages of this approach are comparably low capital and operating costs, ease of operation, simple and proven technology, and options for gradual expansion of facilities. The disadvantages are associated with operating in a relatively open marine environment. This can expose farmed salmon to pathogens and other environmental contamination. Although square cages are dominant in B.C., recent research in Norway has concentrated on alternative farm layouts including circular, octagonal or hexagonal layouts.

A typical B.C. salmon farm is situated relatively close to shore (about 100 metres) and directly occupies an area of about one hectare or less. From 10 to 30 cages are deployed, most often in two parallel rows. The cages are typically square steel cages, normally 12 metres by 12 metres or 15 metres by 15 metres. The squares are supported by floats made of hollow fibreglass, foam or light-weight concrete. A nylon net, usually about 15 metres in depth, is hung from each cage. Frequently, net bottoms are made of double web construction. About 65 per cent of B.C. farms use a predator guard net which is suspended around the perimeter of a set of cages. To prevent nets from becoming fouled with marine organisms, some farmers dip the net webbing in a copper-based anti-foulant before installation.

A main access deck (usually four to six feet wide) runs between the cage layouts, and minor access walkways run between adjacent cages. Each cage is surrounded by fencing rails fastened to the walkway from which the net-cages are suspended. Because salmon farms are typically floating, self-contained facilities, they are held in place with extensive use of anchors which secure the farm's geographic position and minimize billowing of nets.

Each cage may hold up to 20,000 fish and efforts are made to maintain specific stocking densities. Stocking densities range from about 8—18 kg/m³ for Atlantic salmon and 5-10 kg/m³ for chinook salmon.

Figures 6—8 show standard B.C. salmon farming arrangements.

Figure 6. Typical B.C. Salmon Farm Layout

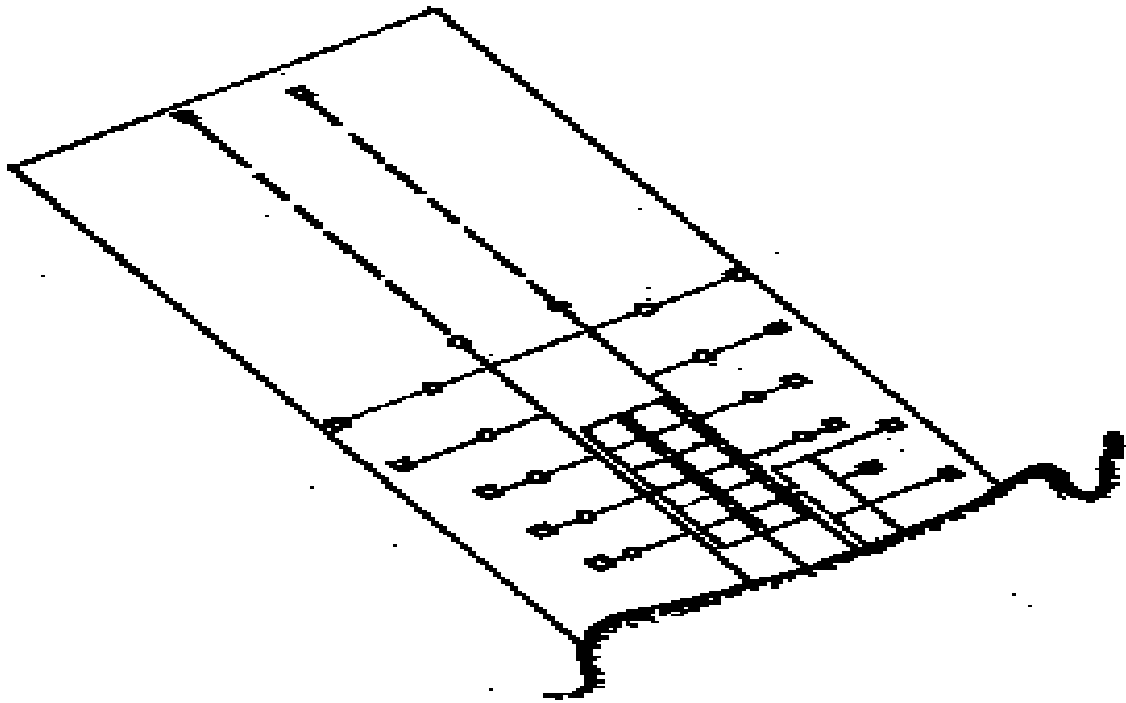
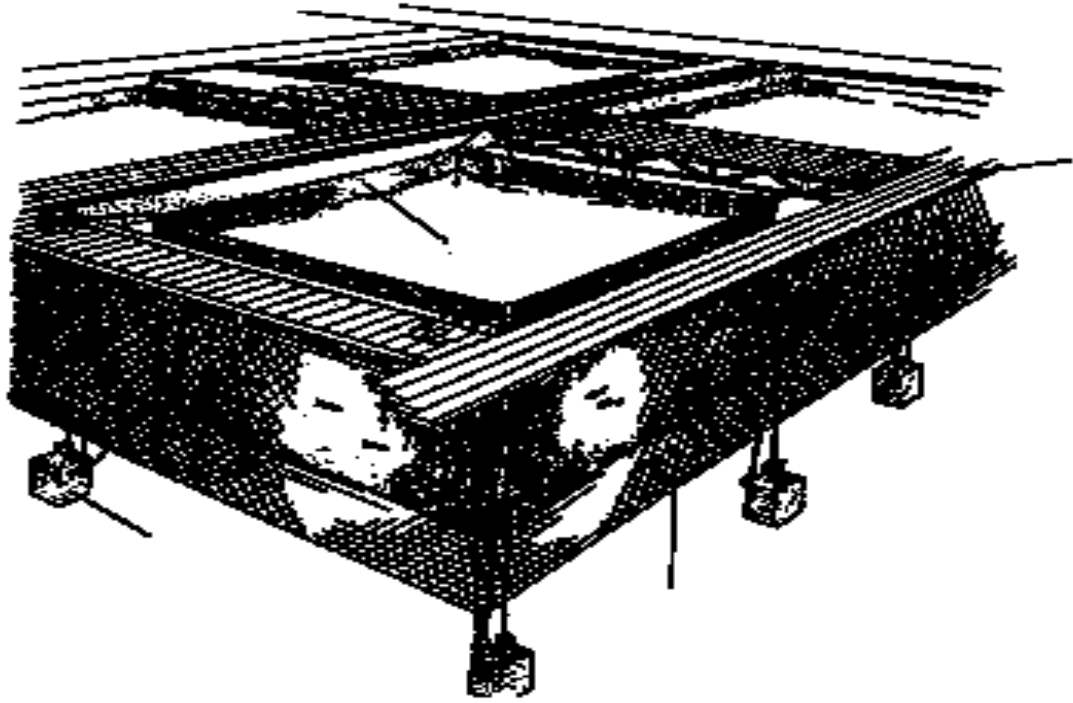


Figure 7. Salmon Farm Net Pens and Anchor Systems.



Source: Ombudsman, 1988

Figure 8. Salmon Farm Net-Cages in the Broughton Archipelago.

Source: BCSFA 1996.

Farmed salmon are fed sized extruded pellets manufactured primarily from small oily fish species such as herring, menhadden, anchovy, pilchard, and capelin that originate mainly from waters off the coast of South America.⁴ Feeding may be done by hand or automatic feeders. Underwater cameras or other systems may be used to observe food intake and prevent excess food delivery. Feeding may occur several times a day or as seldom as twice a day. If fish become sick and require medication, it is added to the feed.

During every production cycle, even under favourable conditions, some farmed salmon die, perhaps from 0.1—0.5 per cent per month. Most dead fish sink and collect near the bottom of the net-cages, where they are retrieved by divers or by lifting the nets. Dead fish are collected in bags and taken to a “mort” container adjacent to each farm site until a marine transport collects and delivers the morts to a composting facility. The main composting facilities are located in Port McNeill, Oyster River, and Courtenay.

Naturally, farmers wish to maximize growth with minimal feed costs and losses of fish. In order to evaluate how well this goal is achieved, samples of cage populations are counted and weighed at selected intervals. This information is then coupled with mortality records and food quantities to calculate weight gain versus food intake.

Caged fish must occasionally be handled to redistribute populations for size grading, medical treatments and salmon lice removal. Stress from handling can adversely affect weight gain and increase fish mortality. Measures used to control stress include automatic sizing equipment and other general husbandry practices such as maintaining optimum cage population densities, maintaining adequate water flow and oxygen concentrations throughout cages, and attention to anti-infection procedures (e.g., net disinfecting and maintaining clean clothing and boots on site.)

Because nets frequently foul with living organisms such as mussels, barnacles, algae and kelp, it is necessary to change nets every month or two during peak fouling periods. The challenge to the farmer is to accomplish net changes while minimizing stress and fish losses, as well as costs. Various methods are used to change nets and to clean fouled nets. Current cleaning technology includes net washers which may be located on a barge or onshore away from the cages, offsite and onsite pressure washers, underwater pressure washers using scuba divers, and dropping the nets to the sea floor, where various sea life remove organic material from nets.

Damage to cages and nets from weather, predators and handling can result in substantial fish loss and affect earnings. Frequent inspections are made of farm cages and predator control nets to detect damage and correct problems that could involve fish escapes or threats to caged populations. Divers are used to examine underwater portions of cages, anchors and mooring lines. Other predator control methods such as the use of acoustic deterrent devices (ADDs) are used on some farms to minimize losses. Many participants in the SAR suggested the need for different technologies to minimize the effects of salmon farming in open net-cages. The EAO review and assessment of all available technologies for salmonid productions is described in Volume 4 of this report.

C. Products and Markets

The bulk of B.C. farmed salmon (95 per cent in 1991) has traditionally been marketed cleaned, fresh, head-on. Recently, however, there has been a shift to value-added products, mainly fillets, in both fresh and frozen forms, primarily in response to U.S. market demand. In 1995 about 15 per cent of B.C.'s production by weight was processed into value-added products and marketed into the U.S. By comparison, it is estimated that 40 per cent of Chilean salmon exports were sold in value-added forms. Although B.C. producers are attempting to respond to the shift in buyers' preferences, value-added processing is labour-intensive and B.C. labour costs are high compared to those of Chile or even Washington State, where some companies send their salmon for filleting in efforts to reduce processing costs.

Eighty-four per cent of B.C.'s farmed salmon production was exported in 1995, primarily to the U.S., notably California, and to a much lesser extent Japan and other Asian countries. About 11 per cent of B.C. production was sold within the province. While the U.S. remains B.C.'s largest market, it has become increasingly competitive. Both Chile and Norway have increased sales into the U.S., eroding B.C.'s share, especially in the central and eastern U.S. markets. B.C. producers have looked increasingly to Japan, China and Korea to offset the increased competition and loss of U.S. market share, but competition is strong. Overall, B.C.'s share of world farmed salmon production has been declining since the early 1990s. Even though B.C.'s production has increased since the late 1980s (see Figure 9), production increases in Norway, Chile and the United Kingdom in the same period have been far more dramatic. In 1995 B.C.'s market share of world production was 4.3 per cent. Just prior to that it was 6 per cent and today it has shrunk to under 4 per cent.

Figure 9. B.C. Farmed Salmon Production, 1985-1996

Sources: Kenney (1996); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies.

B.C.'s competitive advantages are its excellent growing conditions, technical and marketing expertise, and proximity to the large U.S. market. Efficient transportation links between Vancouver and Asian Pacific Rim countries also offer B.C. producers some advantages in delivering fresh product with longer shelf life to the Asian market. The principal weakness of the B.C. industry is factors contributing to higher costs. Labour and feed costs are considerably higher than in Chile, B.C.'s principal competitor in the U.S. and Japanese markets. Feed is the single largest cost factor in grow-out operations. Also, while B.C. has achieved some economies of scale in recent years, it has not done so to the same extent as its major competitors, where output levels are much higher.

D. Financial Performance

The B.C. industry performed poorly in the late 1980s and early 1990s due to relatively high costs and falling salmon prices. This led to widespread business failures and consolidation of smaller firms. With the increased scale and concentration of activity since the early 1990s, financial performance has steadily improved.

Capital expenditures by the salmon farming industry totaled \$16.4 million in 1996, an increase of over 30 per cent from 1995. As shown in Table 7, nets cages, and equipment accounted for the majority of capital expenditures.

Table 7. B.C. Salmon Farming Industry Capital Expenditures, 1995 and 1996

	1995	1996
Nets		\$2,534,000
00		\$3,347,000
00		2,844,000
Cages		3,750,000
0		1,173,000
Barges		826,000
888,000		1,091,000
0		58,000
Boat		2,823,000
0		3,729,000
Trucks		
77,000		
Equipment		
0		
0		

Buildings	1,232,00
0	1,627,00
0	
Other	1,195,00
0	1,579,0
00	
Total:	\$12,400,
000	\$16,373,
000	

Source: Coopers & Lybrand (1997).

Gross income (profits before depreciation, interest and taxes) increased from \$15.7 million in 1993 to over \$30 million in 1995 and 1996 (based on an estimated \$167 million in revenues in 1996). This increase has been due to lower operating costs and more efficient operations, achieved primarily through greater mechanization and consequent improvements in labour productivity. Labour requirements per unit of production have decreased by 15 per cent over the past three years.

Other factors contributing to lower costs include a reduction in smolt costs, realized through expanded hatchery capacity. Economies of scale that the industry achieved in recent years have also contributed to lower costs, particularly in the area of administration. Finally, the shift to Atlantics, with their higher yields and growing density, and to value-added products has contributed to recent increases in profitability.

E. Government Role and Revenue

The provincial and federal governments have generally supported the growth of the salmon farming industry. In the early years of its development, there was direct support (grants and loan programs) to salmon farming companies as well as extensive government-funded research and development. In recent years, however, government financial and economic support has been much reduced. The only government support that salmon farmers directly benefit from is investments through the Venture Capital Corporation—an entity that provides tax credits to investors. Such investments totaled \$2.5 million in 1996, yielding tax credit benefits of some \$750,000. No investments through this corporation are expected in 1997.

The government still provides indirect economic support to the industry through research and development, promotion, financial contributions to industry associations, and unrecovered regulatory costs. These amounts are estimated to total \$3.65 million in 1996, or roughly 2 per cent of the value of B.C. farmed salmon sales. This compares to an estimated average level of support of about 8 per cent of farm revenues in other agricultural industries in B.C.

While indirect financial support from government has contributed to growth of the industry, a number of regulatory policies have not. The moratorium on new Crown land tenures has restricted growth and has led to higher than optimal fish densities at existing sites and less than optimal fallowing of sites. Uncertainty over future regulations and coastal planning processes may also adversely affect investment and growth of the industry.

Taxes and fees paid by the industry to government are relatively small, amounting to less than \$1 million in 1993 and \$4 million in 1996, with the increase largely attributable to the payment of some corporate income taxes in 1996 that were not paid in 1993 because of the carrying forward of previous losses. These figures do not include taxes paid by industry employees or the unemployment insurance or other savings due to the employment created by the industry.

F. Employment and Community Impacts

The salmon aquaculture industry, by its nature is located in or adjacent to coastal communities. These communities have long relied on the natural resources of the land and sea for their economic and social prosperity. Traditional natural resource industries such as fishing and forestry, and more recently, tourism, remain the large employers in these communities. The ongoing restructuring of these industries (forestry, fishing), however, continues to negatively impact these coastal communities, resulting in fewer job opportunities. Since the salmon aquaculture industry operates the entire year, it offers steady employment opportunities, and hence contributes to economic stability in communities that are often subject to the economic volatility of boom and bust fluctuations. This contrasts with many other natural resource industries such as forestry, fishing and tourism which may offer only seasonal work.

Direct employment benefits from B.C. salmon farming for 1993 and 1996 are shown in Table 8.5. Total direct employment is estimated at 1,142 person years in 1996, a slight increase from 1993. Employment in grow-out operations has actually fallen, but this has been offset by growth in processing and transport jobs. Overall, employment per unit of production has fallen, reflecting the increasingly mechanized nature of operations.

Although these employment figures are perhaps not large compared to other economic sectors, they are substantial for individual communities, and the jobs are certainly important to the individuals who hold them, as confirmed by the hundreds of letters sent to the SAR by these individuals.

Table 8. Direct Employment in the B.C. Salmon Farming Industry (person years)

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

*Excludes employment at the recently completed Engelwood plant in Port McNeill which began operating in December 1996 and employs about 40 people.

Sources: ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies.

Almost half of direct employment in the industry is concentrated in the Campbell River and Comox-Courtenay areas, as shown in Table 9. Employees are generally hired from the local area. The major companies report very stable work forces, particularly for more senior positions. Turnover is highest at remote grow-out sites, because of the long shifts at those operations.

Table 9. Direct Salmon Aquaculture Employment by Community (person years)

	1993
	1996
Campbell River	278
	425
Comox/Courtenay	62
	115

Tofino	66
	98
Port Hardy	47
	84
Port Alberni	80
	64
Ucluelet	24
	56
Powell River	85
	37
Port McNeill	17
28*	
Nanaimo	25
	16
Sechelt	87
	14
Other Non-urban	215
	132
Greater Vancouver and Victoria	87
	73
Total Direct PYs:	1,073 1,114

*Excludes employment at the recently completed Engelwood plant in Port McNeill which began operating in December 1996 and employs about 40 people.

Sources: ARA (1994); Coopers & Lybrand (1997); and data from 3 non-BCSFA companies).

Wages for workers vary by position. Farm and hatchery workers generally earn between \$9 and \$15 per hour; processing employees between \$9 and \$12 per hour; supervisory workers between \$12 and \$20 per hour; managerial workers between \$15 and \$20 per hour; and senior management in excess of \$20 per hour. Wages paid in 1996 totaled \$36.4 million, with average annual earnings per employee at \$32,000, which is roughly equal to the average earnings across all industries in B.C.

In addition to direct employment, the industry generates employment in other industries as a result of the goods and services it purchases. Feed is the largest industry purchase, accounting for almost 40 per cent of total production expenditures in 1996. Two B.C. suppliers rely heavily on salmon farming purchases as a source of revenue, while for the others, salmon farming purchases are a minor revenue source. The industry also relies heavily on marine transport, with significant purchases of marine towing and barging services, marine supply, boats, engines and related services. Salmon farming purchases represent substantial portions of revenues for many local suppliers. Major suppliers to processing plants include containers and box manufacturers. Two box company manufacturers in Campbell River employ 48 full-time employees, and these companies in turn have a number of suppliers that produce income and employment, as do all other salmon aquaculture service sector companies.

Aside from direct employment benefits, the industry generates 275 person years of employment in key supplier industries (e.g., feed distributors, marine transport, net and cage suppliers and container and box suppliers – mainly based in the greater Vancouver area), and another 820 person years in other industries due to the purchase of goods and services for salmon farming, for a total of 1,095 person years of indirect employment. Direct and indirect employment combined in 1996 was 2,237 person years.

Many of the jobs available in the industry are entry-level positions, thus providing opportunities for sectors of the workforce that may have a more difficult time finding work. Specifically, as opportunities for youth and people with less education become fewer, other employment opportunities become more valuable. Women have found opportunities in the salmon farming industry, particularly in the processing sector. At two such facilities, Brown's Bay and Englewood, the number of women employees is roughly double that of men. More employment opportunities in general, enable people to live and work in their communities or the communities of their choice rather than being forced to relocate in a larger urban centre in order to find employment. The land-based aspects of the industry (processing, hatcheries) contribute to the tax-base of the communities in which they are located. While this contribution is dwarfed by larger industries such as forestry and mining, the presence of aquaculture often provides the critical mass for maintaining infrastructure, which then allows and encourages new businesses to establish themselves. This is especially relevant as the federal and provincial governments continue to divest interest in facilities such as airports and harbours to local communities.

While hard to quantify and notwithstanding the fact that First Nations have experienced negative impact from salmon farming (see Chapter 9), overall, the community impacts of salmon aquaculture appear to be positive. This relates directly to the type of economic benefits that it offers to coastal communities with few other options. Year-round employment opportunities are provided for a wide range of the workforce, including displaced resource industry workers, young people, women, and less-educated people. The stability that this adds to small coastal communities is the major benefit of the industry. The key to maintaining this net positive impact is to continue to consider the potential social effects when managing the salmon aquaculture

industry and to manage the environmental issues so that they do not continue to be points of conflict.

G. Impacts on Wild Salmon Markets

B.C.'s wild salmon production has been declining in recent years (as shown in Table 10), particularly for coho and chinook, the two wild salmon species that compete in the market place most directly with farmed salmon.

Table 10. B.C. Wild Salmon Production by Species, 1991-1995 (tonnes)

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

Source: Kenney (1996).

Despite the reduction in B.C. supply and growth in consumer demand, prices for B.C. wild salmon have fallen sharply over the past ten years. Prices in 1996 for all species except sockeye are 30 to almost 50 per cent below what they were in 1985. The real decline in prices, taking into account inflation, would be even more pronounced. The world market governs the prices that B.C. producers receive for their salmon, and world markets are influenced by significant recent increases in salmon supply, notably from the U.S., Japan and Russia. B.C. wild salmon production is small by comparison to the combined production of these countries. Much of the U.S. and Japanese production is enhanced—ocean ranched salmon from government funded and operated hatcheries.

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

The increased supply of both wild and farmed salmon underlies the decline in B.C. wild salmon prices. B.C. farmed salmon production accounts for less than five per cent of the world total and less than two per cent of the total world farmed and world production combined. By itself, B.C. farmed production has a relatively insignificant effect on salmon prices. If B.C. farmed production were to disappear, any price impact would be short-lived as other countries which

compete with B.C., in particular Chile, expanded their production and sales into the vacated markets.

CHAPTER 3. THE EXISTING SALMON AQUACULTURE MANAGEMENT SYSTEM IN BRITISH COLUMBIA

British Columbia’s existing system for managing salmon aquaculture consists of a variety of statutes, regulations, policies and guidelines, and institutional structures. Although jurisdiction over salmon farming is primarily shared by the provincial and federal governments, local governments and First Nations have strong interests in, and some direct control of, its management. Table 11 below summarizes the jurisdiction and legislative mandates of these governments. A more detailed description is provided by Ann Hillyer in “The Management and Regulatory Framework for Salmon Aquaculture in B.C” in Volume 4.

Table 11. Roles and Responsibilities in Managing Salmon Aquaculture Activities in B.C.

Organization	Source of Management Authority	Primary Management Function
PROVINCIAL GOVERNMENT		
Ministry of Agriculture, Fisheries and Food (MAFF):		
Aquaculture and Commercial Fisheries Branch, Licensing, Inspection and Field Services	<i>Fisheries Act</i>	<ul style="list-style-type: none"> • issue and monitor salmon aquaculture operating licences
Aquaculture and Commercial Development Fisheries Branch, Licensing, including Inspection and Field Services	<i>Aquaculture Regulation</i>	<ul style="list-style-type: none"> • review and approve Aquaculture Plan and monitors ongoing operations, preventing escapes, predator control and reporting of drug use
Animal Health Branch and	<i>Animal Disease Control Act</i>	<ul style="list-style-type: none"> • provide authority to limit spread of disease to deal with infected animals (Act does not cover fish diseases at present)
Animal Health Branch	<i>Pharmacists, Pharmacy Operations and Drug Scheduling Act</i>	<ul style="list-style-type: none"> • regulate the use of medicated feeds and veterinary drugs
Animal Health Branch	<i>Veterinary Drug and Medicated Feed Regulation</i>	<ul style="list-style-type: none"> • issue licences to manufacture and sell medicated feed and to sell veterinary drugs
Ministry of Environment, Lands and Parks (MELP)		
Environment and Lands lands Regions Division	<i>Land Act</i>	<ul style="list-style-type: none"> • allocate and administer tenure of Crown lands for salmon farms sites

Environment and Lands Regions Division	<i>Waste Management Act and Aquaculture Waste Control Regulations</i>	<ul style="list-style-type: none">• issue waste discharge permits under Act for farms using over 630 tonnes of feed annually• and monitor remaining farms under Aquaculture Waste Control Regulation
Environment and Lands Headquarters Division	<i>Waste Management Permit Fees Regulation</i>	<ul style="list-style-type: none">• collect fees for discharging contaminants
Environment and Lands from Headquarters Division	<i>Freshwater Fish Regulation (Wildlife Act)</i>	<ul style="list-style-type: none">• control the transportation of fish and eggs or in non-tidal waters in B.C.
Environment and Lands Regions Division	<i>Wildlife Act</i>	<ul style="list-style-type: none">• issue permits to kill or trap small mammals such as river otter and mink when out of season

Ministry of Small Business, Tourism and Culture

Archaeology Branch covered heritage value to B.C., a aboriginal people Land Use Coordination use planning processes for Crown Office (LUCO) zones in some areas collection and resource inventories	<i>Heritage Conservation Act</i> • protect objects and land, including land by water, that have community or an provincial policy • coordinate land land including coastal • coordinate and manage maintenance of coastal and mapping
FEDERAL GOVERNMENT Department of Fisheries and Oceans (DFO) Habitat Enhancement Branch fish habitat from deleterious Habitat Enhancement Branch which have the potential to habitat under the Policy for Habitat Marine Environment conduct and Habitat Division, Science Branch Aquaculture Division, where they Science Branch Aquaculture Division, transfer of fish eggs into the country and Science Branch import Coast Guard plans for salmon farm where farm is navigable waters or if farm's impede navigation	<i>Fisheries Act</i> • protect fish and discharges <i>Fisheries Act</i> • assess proposals adversely affect fish the Management of Fish provide scientific and expert advice and research on habitat issues, on request <i>Marine Mammal Regulations</i> • issue licences to kill seals and sea lions <i>(Fisheries Act) and Fishery</i> are attacking fish farm stock, and issue <i>(General) Regulations</i> authorizations to operate ADDs <i>Fish Health Protection</i> • regulate <i>Regulations (Fisheries Act)</i> across provincial boundaries, and issue permits <i>Navigable Waters</i> • approve <i>Protection Act</i> located on improvements could
Agriculture and Agri-Foods Canada Canadian Food farmed fish for export out of province and	<i>Fish Inspection Act</i> • inspect

Inspection Agency
samples of farmed fish to
antimicrobial compounds,
heavy metals
Canadian Food
inspecting veterinary biologics
Inspection Agency
Canadian Food
for medicines or drugs included
Inspection Agency
by humans
Health Canada
Bureau of Veterinary Drugs
which drugs may be sold in Canada, for
which species, classifying
microbial diseases or
the control of external
through feed or injection
Pest Management
registration and labelling of pest control
Regulatory Agency
classifying pesticides as
microbial or other pests
animals or used to control
administered externally
Environment Canada
Canadian Environmental
federal environmental assessment to be
Assessment Agency

conduct random test

detect residues of

pesticide residues and

Health of Animals Act • govern

Feeds Act • set requirements

in feeds for fish consumed

Food and Drug Act • govern

what conditions and in

drugs as products for

internal parasites or for

parasites administered

Pest Control Products Act • regulate

products in Canada,

products used to control

in the environment of

external parasites

Canadian Environmental • require a

Assessment Act (CEAA)

conducted where triggered under the Act

FIRST NATIONS

Kwakiutl Territorial Fisheries

communication,
Commission (KTFC)

regarding

traditional

identified by the First Nations affected

agreement
Central Region Board
discretion, may review any plan,

agency,

planning

to aquaculture in Clayoquot Sound

LOCAL GOVERNMENT

Regional Districts
administer Official Community Plans
and Municipalities
land uses and

implemented using

permits, and prepares and

Use Bylaws for planning

including the surface

MOU between the Province •
MOU establishes process for

of British Columbia and the
consultation and information sharing

Kwakiutl Territorial Fisheries
siting and licensing decisions in the

Commission territories

(December 10, 1993) by the

Clayoquot Sound Interim • at its

Measures Extension
application, permit, decision, report, or
Agreement between the
recommendation made by any ministry,

Province of British Columbia
or panel charged with management or

and the Hawiith of the related

Tla-o-qui-aht First Nations, the
Ahousaht First Nation, the
Hesquiaht First Nation, the
Toquaht First Nation and the
Ucluelet First Nation
(April, 1996)

Municipal Act • prepare and
containing policies about
development, which are
zoning bylaws and
implements Rural Land
and regulating use of land
of water

I. Provincial and Federal Division of Responsibilities

The province has elected to exercise its jurisdiction with respect to the proprietary aspects of the salmon farming industry to take a prominent role in the management of the salmon farming industry. Direct provincial controls over the industry are applied through approvals required under the:

- Land Act—*a grant of Crown land issued by the Minister of Environment, Lands and Parks is usually required for a marine grow-out site,*
- Fisheries Act:—*every aquaculture business operation requires a licence from the Ministry of Agriculture, Fisheries and Food (this by policy excludes federal and provincial enhancement and hatchery facilities), and*
- Waste Management Act:—*all operations discharging to the environment must be in compliance with Regulations under the Fisheries Act (Aquaculture Regulation) and under the Waste Management Act (Aquaculture Waste Control Regulation, Land-Based Fin Fish Waste Control Regulation) and farms using feed exceeding 630T/yr require a permit.*

As outlined in the review terms of reference¹ these are the three key legislative tools for review under section 40 of the *Environmental Assessment Act* to review:

... processes, practices and procedures in use under the other enactment that are pertinent to decisions under it in relation to applications for approvals and the renewal, amendment, cancellation and suspension of approvals, (approval processes), and

... the methods in use under the other enactment for the prevention or reduction of adverse effects of projects that are the subjects of applications for approvals under the other enactment (mitigation methods).

The issuance of a Crown tenure for the grow-out site is really the threshold approval process. Without a tenure, there will be no salmon farm on Crown land and assessment and recommendations around this approval process are essential to the review.

This report focuses on reporting conclusions of the above examinations and, in accordance with the Act, recommends improvements to mitigation methods and approval processes throughout the report (approval process are summarized in Chapter 15).

Several provincial statutes provide a basis for mitigation measures to avoid adverse effects associated with salmon farming, but these provisions are not unique to salmon farming and are applicable to a range of activities generally in a prohibitive or prescriptive manner. These statutes include the:

- *Drug Scheduling Act and Veterinary Drug and Medicated Feed Regulation,*
- *Wildlife Act and Freshwater Fish Regulation,*
- *Health Act,*
- *Heritage Conservation Act,*
- *Water Act, and*

- *Environmental Assessment Act (for groundwater extraction).*

The federal government has a constitutional authority over sea coast and inland fisheries (which has been interpreted to extend to marine mammals) and has prime responsibility to ensure the preservation and conservation of wild stocks. Accordingly, DFO has a strong interest in protecting the wild stocks. Similarly, with a mandate for navigation and shipping, DFO is now responsible for the Coast Guard and also has a mandate for ensuring salmon farms do not interfere with these activities. A number of key federal approvals or exemptions are required by salmon farms under the following:

- *Fisheries Act:*
 - *Fishery General Regulations and Marine Mammals Regulation: licences to kill seals and sea lions; authorization for ADD's*
 - *Fish Health Protection Regulations: certification of importing hatcheries; permitting of imports of eggs.*

- *Navigable Waters Protection Act (if a permit required will trigger the Canadian Environmental Assessment Act).*

A review of the approval processes for these federal processes was not undertaken, although this report includes some recommendations to the federal government with respect to the application of these approvals. Also, a number of federal statutes affect the salmon farming industry by managing or controlling the use of substances relied on by the industry:

- *Health of Animals Act,*
- *Feeds Act,*
- *Food and Drug Act, and*

- *Pest Control Products Act.*

The recommendations may have implications for these statutes, but specific recommendations are not made regarding those federal statutes which generally control the drug approval process for use by humans and in the food industry as a whole.

In 1988 the federal and provincial governments signed a MOU stipulating which agencies would lead (DFO for federal government; MAFF for provincial government) and describing respective responsibilities for administering and regulating aquaculture. Under the MOU, the federal government maintains regulatory authority for:

- health of fish in aquaculture facilities,
- conservation and protection of wild fish stocks and habitat with respect to aquaculture, and
- *protection of navigable waters.*

In addition, outside of the MOU, the federal government maintains its regular responsibilities for food and public health safety, which are managed under laws of more general application but relate to salmon aquaculture through drug approvals and drug residues monitoring.

The province has authority for:

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

MELP has entered into administrative agreements with MAFF to clarify roles and responsibilities and to establish a basis for cooperative administration of salmon aquaculture activities with respect to Crown land and waste management.

In 1995 the federal government, through DFO, adopted a “Federal Aquaculture Development Strategy” which sets out basic principles for the development of all forms of aquaculture in Canada and describes a strategic plan and implementation structure for supporting the Canadian aquaculture industry. The provincial government intends to develop a written corporate strategy. Some overarching provincial principles and draft land use goals which bear on salmon aquaculture management do exist.²

The following sections describe the current management system for salmon aquaculture in B.C., organized according to major functional responsibilities.³ These management provisions are expanded upon in subsequent report chapters that provide specific analysis of the technical issues (see Chapters 4 through 8 which incorporates some repetition in this report).

As outlined above and discussed in the following material, the B.C. salmon aquaculture industry is subject to a diversity of existing regulatory and policy requirements. In general, the requirements are aimed at preventing or minimizing adverse environmental impacts, resolving conflicts with other coastal uses and ensuring public health safety. The existing management framework is outlined in the remainder of this chapter and pertinent aspects are discussed again in the chapters dealing with each of the key issues (see Chapters 4 to 8). Accordingly, there is some overlap in discussion of the legal and policy framework.

II. APPROVING FARM SITE TENURES

Most salmon farms in B.C. operate on provincial aquatic Crown land. To operate a salmon farm on provincial Crown land the farm operator must first obtain a tenure. The Regional Operations division of MELP is responsible for administration and allocation of Crown lands in B.C. Land is made available under the *Land Act* for salmon aquaculture under three types of tenure—an investigative permit, a licence of occupation, or a lease. Tenures are issued in response to individual applications by a salmon aquaculture proponent. Each application is investigated on its merits in relation to various information about the proposal that is acquired from the applicant, referrals to other agencies and groups, and field inspections. Specific policies and procedures that are followed by MELP in accepting and processing applications are documented in a ministry policy statement for salmon aquaculture.⁴ Figure 10 shows the general steps in obtaining provincial salmon farm approval, with details of First Nations consultations discussed in chapter 9.

The process for authorizing a salmon farm site usually begins with the proponent making application for an investigative permit which allows for the temporary occupation (up to one year) of Crown land to determine the feasibility of developing a salmon farm at that particular site. During this period the proponent examines the physical and biological characteristics of a site, including water quality, current speeds and storm protection. If the site has basic biophysical capability for salmon aquaculture, and if the proponent wishes to proceed further, the proponent may apply for a licence of occupation or a lease. Leases require the applicant to obtain a legal survey of the site and to pay a rental premium in recognition of the right of exclusive possession that a lease offers. A tenure applicant may choose to apply for a licence or lease without first obtaining an investigative permit.

Land Act licence or lease tenure applications must be accompanied by an aquaculture development plan that describes the nature and scope of the proposal and contains basic information on factors relevant to site capability and other coastal users and resource values in the vicinity. Application packages are reviewed for completeness and compliance with siting criteria and other policy requirements. Applicants are required to advertise in the local newspaper their intent to apply for a salmon aquaculture tenure, and public comments may be registered with MELP.

Figure 10. Generalized Salmon Farm Approval Process 5

Existing siting criteria are in the form of guidelines, thus allowing MELP to exercise some discretion when considering an application. Existing siting guidelines are listed below.

Existing Salmon Farm Siting Guidelines

1. *Applications will not be accepted in areas fronting and 1 km seaward of provincial parks and ecological reserves.*
2. All marine finfish lease and licence applications will be:
 - 3 km from an existing finfish lease or licence with consideration given to existing lease and licence applications, existing investigative permits and existing investigative permit applications,
 - 1 km from the mouth of a salmonid stream,
 - 125 metres from an existing shellfish lease or licence, with consideration being given to an existing application for shellfish tenure, and
 - 125 metres from a wildstock shellfish bed considered important based on the joint recommendation of MAFF, MELP and DFO.
3. *The spacing distance between a marine finfish lease or licence and a salmonid stream may be increased upon the joint recommendation of MAFF, MELP and DFO.*
4. *The marine finfish spacing distance may be increased in respect to shellfish applications and tenures if concerns are received from adjacent shellfish farmers or applicants and if recommended by MAFF.*
5. *The marine finfish spacing distance may be increased in relation to wildstock shellfish beds upon the joint recommendation of MAFF and DFO.*
6. *The (minimum) spacing between freshwater finfish leases and licences must be 1 km.*

Once an application package is complete, MELP distributes it to various government and non-government organizations for review and comment. The standard referral distribution is to about a dozen or more agencies or groups, including federal and provincial agencies, relevant local governments and First Nations, and other interested non-governmental groups. Referral contacts are asked to review the proposal from the perspective of their regulatory authority or interest, advise on whether or not the proposal should proceed, or advise on amendments or conditions that should become part of the approval. Referral comments are collected and assessed by MELP as a basis for an adjudication decision.

MELP has considerable discretionary authority in making salmon farm siting decisions. Decision criteria are not set out in regulation—adjudication decisions reflect an “on balance” consideration of the information assembled during the application process in relation to policy provisions and guidelines. Primary influences on MELP’s decisions are referral comments and land use zoning designations that may or may not extend to the area in question. In particular, as a written policy, salmon farm siting decisions are consistent with local government zoning bylaws⁶ and with Coastal Resource Interests Studies (CRIS) designations which are in effect for six coastal regions of B.C. CRIS designations include “red zones” within which there is no opportunity for salmon

aquaculture due to excessive user conflicts.⁷

6 *Pursuant to their land use planning and zoning powers under the Municipal Act, some local governments (e.g., Comox Strathcona Regional District) have enacted zoning bylaws which contain specific salmon aquaculture siting requirements.*

7 *Although new salmon aquaculture applications are not accepted by MELP in CRIS Øred zones," pre-existing salmon farms and some applications for salmon farms that were in-stream during the CRIS planning process have, in accordance with MELP's policy, been approved in Øred zones." This has led to complaints by groups that were involved in the CRIS planning processes, and has affected the credibility of the CRIS planning processes and products.*

At the application adjudication stage, proposals are either disallowed, normally for reasons of site unsuitability, or they are approved subject to a number of conditions, including the requirement to obtain all other necessary approvals, one of the most important being the provincial aquaculture licence from MAFF (see below). Other conditions include the requirement to pay an annual rental and to post a site restoration bond to provide an assured source of funds for site clean-up in the event of abandonment.

Between 1986 and January 1997, BC Lands accepted over 475 investigative permit, licence or lease applications for salmon aquaculture. At present, there are 122 site tenures, not all of which are being used for active grow-out of farmed salmon (a proportion of sites is routinely fallowed).

Licence tenures are issued for 10 years and leases for 30 years. Almost all existing salmon farms in B.C. are authorized under a 10-year licence tenure. There are fewer than 10 leases in existence. Tenures may be replaced upon application when they expire, subject to policy requirements that are in effect at the time. Replacement tenures do not go through a full referral process and site evaluation, on the presumption that the original tenuring decision dealt with site suitability questions.⁸

A moratorium on processing new salmon farm site applications has been in place since April 1995, when the provincial action plan for salmon aquaculture was announced by the provincial government. Prior to and since the moratorium, a number of applications for new sites had been filed with MELP and these remain held in abeyance, pending government's response to the salmon aquaculture review. The existing approved salmon farm tenures directly occupy less than 200 ha of aquatic Crown land, which represents a very small proportion of B.C.'s coastal land base.

III. Licensing Salmon Farm Production and Operations

Once a salmon farm site tenure is approved, the main provincial mechanism for regulating salmon aquaculture production and operations is the aquaculture licence. All operators are required to obtain an aquaculture licence, renewable annually, for each farm site. They are issued under authority of the provincial *Fisheries Act* and the associated *Aquaculture Regulation*,⁹ and are administered by MAFF.

Aquaculture licences contain a variety of general terms and conditions that apply to all farms, and also special provisos that are customized for particular farms to address site-specific issues. Some of the general terms and conditions in the licence are requirements to:

- *comply with an approved aquaculture development plan, which must specify the salmon species to be farmed and maximum permitted production levels,*
- *take reasonable precautions to prevent escapes and promptly report escapes that occur,*
- *ensure that fish are given proper care and attention to meet their biological needs,*

8 *As part of the Provincial Action Plan for Salmon Aquaculture, an interagency review committee comprising representatives from federal and provincial agencies was established to review and make recommendations on applications for salmon aquaculture tenure replacements and amendments to existing salmon farms.*

9 *Fisheries Act, RSBC, 1996, C. 149, and Aquaculture Regulation, BC Reg. 364/89.*

- employ reasonable practices to prevent predators and disease, and
- *comply with all laws, bylaws or orders from any government authority which affect the aquaculture facility.*

Once an aquaculture licence application is received, MAFF staff assess the site in relation to MAFF biophysical capability inventories and the site's natural capacity to assimilate and disperse organic waste discharges. A computer modeling tool is used to estimate waste discharge impacts and to help MAFF staff arrive at a proposed maximum salmon production level. Proposed sites are normally visited by MAFF staff to inspect specific site characteristics. Following these reviews and through discussions with the applicant, MAFF sets a maximum production level for the site and establishes site-specific licence conditions as needed, including a description of the type of physical net-cage equipment and anchoring systems that will be used. Most site-specific requirements are described in the aquaculture development plan, which forms part of the aquaculture licence document and is thus enforceable.

Salmon farm operators are required to supply annual statistical reports to MAFF, indicating the amount of fish stocked, the amount of fish harvested and sales by species. MAFF also requires fish processors to provide cultured finfish quarterly reports indicating the amount of fish processed and the locations of the source of fish. MAFF staff visit each salmon farm once a year to assess the operation. Based on information assembled from annual reports and site monitoring, aquaculture licences may be suspended or revoked (in addition to other penalties, such as fines, set out in the provincial *Fisheries Act* and the *Aquaculture Regulation*) if the holder violates the provisions of the Act, regulations or licence conditions. In practice, a licence has never been suspended or revoked.

In April 1996, the provincial *Farm Practices Protection (Right to Farm) Act* came into effect, protecting provincial farmers, including salmon farmers, from nuisance suits and injunctions that may otherwise potentially result from "normal" salmon farming operations, where "normal" operations are defined in provincial standards. Under the Act, a Farm Practices Board is set up to hear complaints about farm noise, odour or other disturbances. In addition, the Act contains provincial powers that if applied would prevent local governments from adopting bylaws that restrict or prohibit salmon farming use beyond the established provincial standards. MAFF is now in the process of defining provincial standards.

A. Preventing Escapes

Preventing farmed salmon from escaping is an objective of all salmon aquaculture operations. Escapes are presently controlled, to a limited degree, under the *Aquaculture Regulation* and through the aquaculture licence. Farmed salmon escapes must be reported promptly to MAFF and also to DFO. Prior to attempting to recapture escaped farm salmon, an operator must obtain a special permit from DFO. In practice, past efforts to recapture escaped farm salmon have been limited and only marginally successful. Salmon escapes have been monitored since 1991 through a joint MAFF and DFO program, developed initially to assess the presence of Atlantic salmon in B.C. coastal streams. In 1992, an expanded program, *Atlantic Salmon Watch*, was launched to monitor commercial and sport catches and observations of Atlantic salmon.

IV. MANAGING FISH HEALTH

There are several existing federal and provincial regulations and policies in place to restrict the movement of farmed fish and fish eggs, and to maintain on-site farmed fish health, in efforts to protect wild species from risks of infectious diseases and other ecological impacts.

A. Transport of Fish and Fish Eggs

At the federal level, the *Fish Health Protection Regulations*, under the federal *Fisheries Act*, prohibits the importation of cultured fish or eggs¹⁰ of wild fish without an import permit. Import permits are issued only to persons that first obtain a certificate from a fish health official certifying that the imported fish or eggs¹⁰ have been inspected and come from a disease-free source or are considered to not be harmful to the protection or conservation of fish in the province. Certification is based upon repeated testing of fish at a facility. The *Fish Health Protection Regulation* is accompanied by a manual of compliance that sets out testing, sampling and certification procedures, as well as procedures for egg disinfecting.

In addition to this regulation, salmon importation is subject to regional “Atlantic and Pacific Salmon Import Policies.” Both policies stipulate that only surface-disinfected fertilized eggs are to be imported, and set out a number of other protocols aimed at minimizing the risks of introduction of infectious diseases. Under the Pacific salmon import policy, Pacific egg importation is permitted only for research or broodstock development programs, with a maximum annual limit on egg import numbers. At present, a numerical limit on Atlantic egg imports is not specified. All imported eggs must be held in quarantine immediately upon arriving in B.C. If a disease agent of concern to DFO is detected during the quarantine and isolation periods, all stocks at the facility must be destroyed and the facility disinfected.

As a part of normal salmon aquaculture practice, farmed fish are often transferred from one location to another within the province. To minimize risks of transferring diseases along with the transferred fish, federal and provincial regulations prohibit the transport and transplant of live fish unless authorized by licence or permit. In B.C. a federal-provincial transplant committee has been responsible since 1977 for reviewing applications to transplant live fish and live eggs.

At the provincial level, the *Aquaculture Regulations* under the B.C. *Fisheries Act* require that any person introducing fish into the province or moving fish within the province, for the purpose of carrying out an aquaculture business, must be the holder of a valid aquaculture licence. For the purposes of administering this requirement, the province has been divided into four coastal and five inland zones. Transfers of healthy fish within zones can occur with few restrictions, however, transfer between zones is more stringent.

Also at the provincial level, the provincial *Wildlife Act* and the associated *Freshwater Fish Regulation* prohibit anyone from transporting eggs and juvenile fish except where authorized by permit.

B. Disease Control

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

10 *Although Atlantic fish eggs have been imported by the industry, there is no importation of live fish to support the B.C. salmon farming industry.*

MAFF is responsible for monitoring diseases that are of concern to farm stock and which may be of significant economic importance to the B.C. salmon farming industry. The *Aquaculture Regulations* under the provincial *Fisheries Act* are currently the source of authority for controlling fish disease.

The *Animal Disease Control Act* deals with disease detection, controlling disease sources and pathogens, and implementing measures to reduce the spread of disease. The Act allows the Provincial Veterinarian to require “listed diseases” to be reported. At present, however, the Regulation under the Act does not list any fish diseases as “reportable.” Although legislation has the scope to govern diseases in cultured fish, the isolation, quarantine and disease suppression provisions do not apply to cultured fish. Salmon farmers are not presently required to notify any authorities of any disease outbreaks that may occur on their farms.

MAFF monitors fish disease through its Fish Health Extension Program, where diagnostic services are provided. A provincial Fish Health Veterinarian provides “on farm” service to producers, and works with private veterinarians and the industry to identify diseases and health issues which cause losses to the industry as well as those of importance to animal welfare and public health.

C. Regulation of Drug and Pesticide Use

Disease and pest outbreaks in farmed fish are frequently treated with drugs and pesticides. There are a number of federal and provincial regulations governing the use of drugs and pesticides in B.C. salmon aquaculture. These are designed to ensure their effectiveness and to protect the safety of other organisms and humans.

Products used for control of microbial diseases or internal parasites, as well as products that are targeted on external parasites and that are administered through feed or injection, are regulated as drugs. Products that are administered externally to control parasites are regulated as pesticides. Different regulatory controls apply to drugs and pesticides.

At the federal level, the Bureau of Veterinary Drugs of the Health Protection Branch of Health Canada is responsible for ensuring that drugs registered and regulated in Canada are safe, effective and do not leave potentially harmful residues in food products. Safety concerns involve both the animals being treated and humans that may consume them. The Bureau administers the federal *Food and Drug Act*, which authorizes the drugs that may be sold in Canada for particular health conditions and species. The Act authorizes the government to create regulations that set conditions and standards under which drugs may be prepared for sale, and to establish specific provisions respecting drug labeling, packaging and use. The *Food and Drug Regulations* specify requirements for registration and use of various classes of drugs and provide detailed requirements for drug labelling, which sets out specific information about the use and administration of the drug.

Drug products are licensed with the contents and instructions for administering the drugs listed on the label. Only three antimicrobial drugs are licensed for use on salmon. The drugs are oxytetracycline (trade name Terramycin Aqua), ormethoprim and sulfadimethoxine (trade name Romet-30), and trimethoprim and sulfadiazine (trade name Tribissen). Each of them is administered in fish feed. Only Terramycin Aqua can be used without a veterinary prescription; however, that has occurred only rarely in B.C. Only registered veterinarians are permitted to

prescribe the use of the other two drugs or to deviate from instructions on the label. Veterinarians are, however, permitted to write “extra label” prescriptions for sick farmed salmon using drugs other than the three drugs that are specifically approved for salmon aquaculture.

The federal *Feeds Act* provides for the registration and prescription of standards for feed consumed by livestock, which includes fish. The *Feeds Regulation*, issued pursuant to the Act, specifies that drugs can be used in fish feeds, identifies the maximum permissible level of drug permitted in final rations, provides directions for use of medicated feed and identifies the maximum amount of drug that is permitted. The “Compendium of Medicating Ingredient Brochures” contain instructions about properly mixing medicated feeds. These brochures are prepared and periodically updated by the Plant Products Division of federal Agriculture and Agri-Food Canada.

Agriculture and Agri-Food Canada also regulate, through a MOU between the federal and provincial governments, the vaccines that are used to prevent disease in farmed fish. As a standard procedure to prevent the occurrence of common fish diseases, vaccines are administered by injection prior to placement of fish into net-cages. This may be followed by revaccination by immersion shortly after placement in net-cages. Importation of veterinary biologics such as vaccines is governed by provisions in the federal *Health of Animals Act*. Regulations under the Act deal with the manufacture and sale of those products. Salmon produced in B.C. are now routinely vaccinated against common diseases.

The Pest Management Regulatory Agency of Health Canada controls pesticides and disinfectants, including products used to control the relatively common problem of sea lice in farmed salmon, and to deal with net fouling. The federal *Pest Control Products Act* establishes the requirements for the registration, packaging and labelling of pest control products in Canada.

Hormones such as testosterone and its derivatives are controlled drugs and are regulated as such under the federal *Food and Drug Act*. Currently, the only hormone being used in salmon aquaculture is a testosterone derivative that has been used for the past three years in broodstock research projects designed to develop non-reproductive, all-female populations of Atlantic salmon and to masculinize chinook salmon. The *Food and Drug Act* does not allow the use of this product in fish that are to be harvested for food.

At the provincial level, the *Pharmacists, Pharmacy Operations and Drug Scheduling Act* addresses the use of medicated feeds. The pharmaceuticals which can be added to fish feed are listed in a Regulation adopted under this Act—the *Veterinary Drug and Medicated Feed Regulation*. The Regulation establishes requirements for issuing and maintaining licences to manufacture and sell medicated feed, the sale of drugs, and provisions regarding storage and dispensing of drugs. For example, the Regulation requires that where veterinary drugs are mixed in medicated feed on the written order of a veterinarian, the licence holder must forward those orders to the Provincial Veterinarian annually with the veterinary drug purchase register.

Additionally at the provincial level, the *BC Aquaculture Regulation* requires salmon farmers to keep a record of drugs administered to farmed salmon. The Regulation also specifies that there must be a drug-free period of 105 days before salmon harvest if a licence holder has administered a drug to a farmed salmon, unless federal *Food and Drug Act* Regulations provide for a different standard or a veterinarian has prescribed a mandatory minimum withdrawal period.

D. Voluntary Measures to Protect Fish Health

Aside from federal and provincial regulatory mechanisms for managing fish health, salmon farmers are naturally interested in preventing disease in their fish and voluntarily follow various fish health protocols, which typically include:

- *use of single-year class sites and fallowing of sites between year classes, where a sufficient number of sites are available,*
- *use of veterinary services for diagnosis, treatment and monitoring,*
- *biosecurity measures, such as ozonation of hatchery intake water and equipment disinfecting, and reliance on groundwater as opposed to surface water,*
- *broodstock screening for potential transfer of pathogens,*
- *surface disinfecting of eggs at hatcheries,*
- *vaccination of fish stocks for various diseases,*
- *culling of eggs and fish,*
- *routine disease monitoring of fish at sea, and*
- *participation in mortality monitoring systems.*

In addition, through the BCSFA, the industry operates a program for “Cooperative Assessment of Salmonid Health” (CASH), where among other things, mortality rates for participating farms are tracked and from which producers attempt to estimate causes of mortality.

V. Regulating Waste Discharges

The provincial *Waste Management Act* and the *Aquaculture Waste Control Regulation* set out requirements governing waste discharged from salmon farms. The Act and the Regulation are administered by MELP.

In general, the *Waste Management Act* prohibits the introduction of industrial waste into the environment, unless in compliance with a valid permit. The Regulation creates an exemption from the requirement for salmon farms to obtain a permit where:

- *total feed use at the farm does not exceed 630 tonnes of dry weight per year,*
- *the use, storage and disposal of materials and wastes on or off the site is carried out in a way that minimizes odour, risk of spillage and impact on wildlife,*

- *there is a monitoring program allowing determination of environmental impacts,*
- *the farmer notifies the regional waste manager of MELP of changes in the operation that alter waste discharge,*
- *the salmon farmer reports pollution caused by the operation and takes steps to prevent recurrence of pollution,*
- *there is an approved contingency plan for procedures to be followed in the event of a major fish kill, including the disposal of fish mortalities, and*
- *specific criteria for the discharge of treated domestic sewage are met.*

Farms that use more than 630 tonnes of feed per year require a permit under the *Waste Management Act* that sets out specific conditions governing waste discharges. The permit may include provisions respecting:

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

Regardless of whether or not a permit is required, all fish farms are required under the Regulation to monitor water quality, with the intensity of monitoring dependent on the level of farm production. To standardize monitoring requirements, MELP has developed “Environmental Monitoring Program for Marine Fish Farms” guidelines, plus a reference document on field sampling methods and analytical procedures. A recent review of regulatory requirements for monitoring and reporting of monitoring results concluded that the program was not functioning very effectively, with both individual salmon farmers and MELP failing to meet program obligations. In April 1995, MELP notified waste discharge permit holders that new monitoring requirements would be adopted, with a view to developing a revised, long-term monitoring program. MELP recently undertook a survey of over 40 farms to obtain information on production levels, diseases present, predator control, fallowing practices, feed usage, etc. Sediment and water samples were collected and analysed, as a basis for assessing environmental impacts. These data are currently being compiled and analysed and were not available in summary form to this review.

Currently, 11 farms in B.C. have waste management permits, with permitted feed usage ranging from 750 to 1,180 tonnes per year. When MELP receives an application for a waste management permit, it is required to provide opportunities for public notice and comment. If a waste management permit is issued and the applicant or any other party considers itself aggrieved by the decision or a provision in the permit, that person may appeal the decision.

A Waste Management Permit Fees Regulation authorizes the collection of fees for discharging contaminants under a waste management permit. An application fee is payable plus an annual fee based on the maximum quantity of contaminants that are discharged into the environment. Annual permit fees for salmon farms range between about \$800 and \$1,100.

Some level of fish mortality is a normal and expected occurrence at fish farms. Where salmon farms require a waste discharge permit they must, as part of the permit, indicate the method used for disposal. There is no requirement for non-permit holders to specify their means of mort disposal; however, the current standard practice for all salmon farmers is to periodically ship their dead fish to composting facilities.

Human sewage discharge at fish farms is regulated under the *Sewage Disposal Regulation* pursuant to the provincial *Health Act* as well as the *Waste Management Act* and Regulations.

At the federal level, the *Fisheries Act* prohibits the deposit of harmful or toxic substances into any waters that are home to fish. If a salmon farm were to discharge wastes that were found to be “deleterious,” it could be subject to prosecution under the Act.

VI. Managing Interactions with Other Coastal Mammals

Predation on farmed salmon by marine mammals and birds is a common issue that salmon farmers attempt to address through a variety of measures, including the use of predator “resistant” equipment, acoustic deterrent technology, and the trapping or killing of predators. The methods that salmon farmers use to attempt to prevent marine mammals and other species from preying on farmed salmon are governed by both federal and provincial legislation.

The *Marine Mammal Regulations*, adopted under the federal *Fisheries Act*, prohibit anyone from disturbing a marine mammal except when fishing under the authority of these Regulations. Seals and sea lions are protected under the federal *Fisheries Act* and may be killed only with a licence issued by DFO. Licences to do so are issued subject to a number of terms and conditions, including:

- *only harbour seals, California sea lions and Steller sea lions may be killed,*
- *only seals and sea lions that are actually taking or attempting to take fish in sea cages may be killed,*
- *the area of killing is the immediate site of the sea cages and killing must not occur outside the boundary of the salmon farm site tenure,*

- *employees who kill seals or sea lions must be proficient in safe firearm use and possess a provincial hunting licence, and*
- *the licence holder must submit quarterly reports on seals or sea lions killed.*

When applying to DFO for a licence to kill marine mammals, the applicant must show that other measures have been tried first to deal with the problem. When the licence is issued, DFO notifies the RCMP, the provincial conservation officer and the federal fisheries officer in the farm vicinity. Licences are issued for one year, renewable if the licensee complies with the terms and conditions. At present, most operating farms possess a valid licence to kill seals and sea lions. At present, DFO does not actively audit the licensing system.

The federal *Migratory Bird Convention Act* provides a number of protective measures for a wide range of birds, including some of the species that have been found to interact with farmed salmon in net-cages, such as waterfowl, gulls and herons. Under Regulations adopted under the Act, permits may be issued by Environment Canada to kill listed species that are seriously injurious to agricultural or other interests in the community. The provincial *Wildlife Act* also protects the killing of most birds without a permit.

Also regulated under the provincial *Wildlife Act* are small mammals such as river otter and mink. A salmon farmer must have a permit to trap or kill these species if trapping or killing them would occur out of season. If the permit is for trapping and relocating the species, MELP staff will refer the salmon farmer to a licensed trapper.

The aquaculture operating licence issued under the provincial *Fisheries Act* by MAFF requires a salmon farmer to take reasonable precautions to prevent marine mammals and birds from preying on farm fish. At some farms, ADDs are used in attempts to prevent mammals from preying on farmed salmon. DFO issues authorizations for farms to deploy and operate ADDs according to specific procedures and requirements. At present, 11 farms operate ADDs.

Some salmon farmers have recently begun to experiment with the practice of lighting salmon cages at night in efforts to increase salmon growth and productivity. The *Pacific Fisheries Regulations* prohibit the use of lights to attract or repel fish, but this prohibition does not apply to the practice of night lighting at salmon farms.

VII. Protecting Human Health and Safety

A. Protecting Humans from Exposure to Drugs and Pesticides

Aside from the various federal and provincial drug labeling and drug and pesticide application controls described above, there are several regulatory controls aimed at preventing unsafe human exposure to drugs and pesticides used at salmon farming sites.

The federal *Fish Inspection Act* governs the inspection of farmed fish for export. It sets out the federal role in ensuring that fish and seafood meet strict national quality standards from the time they leave the water to when they are distributed to the marketplace for export or interprovincial trade. The provincial *Aquaculture Regulation* requires all farmed fish processed to go to a federally inspected plant. The Act gives DFO inspectors powers to enter premises and inspect products. It also prohibits the import, export or possession for export of tainted, decomposed or unwholesome fish. The *Fish Inspection Regulations* under the Act set out the specific requirements for inspections at fish plants. The Regulations require that all fish for export must be processed in a facility for which a prescribed quality management program is in place. Inspection records must be kept for review and audit by DFO inspectors.

DFO randomly tests samples of farmed salmon for the presence of antimicrobial compounds approved under the *Food and Drugs Act* for use on salmon. It also conducts tests for pesticide residues and heavy metals, but does not necessarily test for other drugs that may be prescribed “extra label” by a veterinarian. The regularity of testing is dependent on the performance rating of the facility.

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

A new federal *Fish Inspection Act* (Bill C-64), not yet in force, will facilitate the establishment of the proposed new Canadian Food Inspection Agency, which will have authority for fish inspection.

This bill revises and expands major prohibitions set out in the current Act, and substantially increases maximum penalties for violations of the Act.

A provincial *Fish Inspection Act* also regulates fish processing. The Act requires all plants in B.C. to have both a provincial and federal licence. The Act establishes the basis for appointing inspectors who are authorized to enter premises, boats or vehicles and to take fish samples, and provides inspectors with the authority to seize all fish and containers related to the offence. For purposes of harmonizing the administration of federal and provincial inspection powers, DFO inspectors are appointed as provincial inspectors under the provincial Act. The provincial *Fish Inspection Regulations* prohibit anyone from selling fish intended for human consumption that is tainted, decomposed or unwholesome. It also requires that fish delivered to a processing plant or buying station are accompanied by a statement identifying any drugs that have been administered to the fish being delivered.

That Act contains broad powers for the Minister to require licence holders to submit reports, and this could result in an order from the Minister to require a processing plant or fish buying station to report on any drugs administered to farmed fish which were delivered to that facility.

Since human health effects are associated with aspects of fish health and waste discharge management, and were raised as a concern primarily by First Nations, the Ministry of Health (MoH) undertook a preliminary literature review of information. Since that time, the MoH has been consulting with Health Canada to develop a proposal for a study to address human health effects by:

- *identifying potential human health hazards from both the fish and related farming activities,*
- *assessing any health risks identified above, and*
- *identifying gaps in understanding of health risks associated with aquaculture.*

Two principal areas will be researched, recognizing that the health effects on First Nation peoples are important:

- *direct human health effects (e.g., antibiotic effects)*
- *indirect human health effects (e.g., effects on human consumption).*

Worker safety will be reviewed with workers compensation staff to determine whether or not to include in the study.

B. Shellfish Harvesting Prohibition

Environment Canada maintains the authority to impose bans on shellfish harvesting in the interests of public health safety and has put into place a standing prohibition on public shellfish harvesting within 125 metres of a salmon farm. The restriction is a preventative measure that is based on a concern about possible contamination of shellfish with coliform bacteria from sewage that may be associated with salmon farming operations.

C. Boating and Navigational Safety

As part of the farm site approval process, applications for tenures under the *Land Act* are referred to the Coast Guard to determine if the proposed location of the site will substantially interfere with navigational safety. DFO is responsible for the protection of navigable waters under the authority of the federal *Navigable Waters Protection Act*, within which the Coast Guard is the government agency responsible for ensuring that salmon farms comply with the provisions of the Act.

Any salmon farm located on, under or over navigable waters or having improvements that could impede navigation must have the site, the plans, and the specific works approved under that Act prior to construction. Approval might be conditional upon the certain placement of anchor lines, or a requirement to maintain a certain type and level of lighting on fish farm facilities. A structure that posed too great a hazard to navigation would not be approved.

VIII. Environmental Impact Assessment

Although individual salmon farms in B.C. have not to date been subject to a requirement to proceed through a formal environmental impact assessment, there is the potential for this to occur under the *Canadian Environmental Assessment Act* (CEAA). This Act applies if a federal authority, such as DFO, exercises a regulatory duty in relation to a project, such as issuing a permit or licence. Any salmon farm that requires approval under the Navigable Waters Protection Act will be considered under CEAA and will trigger at least a screening by DFO for potential environmental effects. A number of provisions from the existing federal *Fisheries Act* also trigger the requirement for a federal environmental assessment.

Salmon aquaculture developments are not required to obtain a project approval certificate under the provincial EAA11. The question of whether or not they should, however, is within the terms of reference of this provincial Salmon Aquaculture Review (see Chapter 15).

11 Groundwater extraction and surface water diversion projects in association with commercial salmon aquaculture may potentially be “reviewable” projects under the provincial Environmental Assessment Act.

CHAPTER 4. SALMON FARM SITING 1

Although B.C.'s coastline is vast—over 27,000 kilometres—and only an extremely small percentage of that is occupied by salmon farms, significant localized concerns and conflicts have arisen over salmon farm siting. These originate from several sources:

- many coastal users have interests in locations with the same characteristics that make a site valuable for salmon farming, such as closeness to population centres, good marine water quality, access to fresh water, accessible shoreline, and safe moorage;
- although the total number of people negatively impacted by salmon farming is quite small, impacts that have occurred are significant to those affected;
- perceptions about salmon farming appear to be affected by experiences of the 1980s when salmon farming was far less regulated and managed than at present;
- there are concerns that ecological impacts of salmon aquaculture are not well understood, leading to the view that sites should be restricted until the safety of the industry is confirmed;
- siting decisions are frequently made in the absence of good information on potential impacts on other resources and resource users; and
- siting decisions have sometimes been made without meaningful consultation with affected interests.

First Nations have expressed many of those concerns. The decision-making process regarding issuance of tenures up until recently and especially prior to 1990, when many salmon farming tenures were issued, did not follow the consultative process currently being undertaken to determine whether or not the activity related to the issuance of the tenure would infringe aboriginal rights.

In discharging its responsibilities under the Land Act, MELP (Regions Division) is the lead agency for accepting, evaluating and issuing tenures on aquatic Crown land for salmon farming. The ministry's policies and procedures for allocating salmon aquaculture tenures are described in Chapter 3. MAFF also has a role to play in salmon farm siting because a farm cannot proceed until that ministry approves an aquaculture licence, issued under the provincial Fisheries Act.

The two agencies' policies and procedures respecting salmon farm siting and operations reflect an objective to provide opportunities for salmon farming, subject to the anticipation, prevention or minimization of impacts and conflicts from salmon farming using several main measures, as described in Table 12. These measures are assessed in the following sections, and Appendix 5 provides a summary assessment of these existing measures on the basis of normative criteria.

1 See also Catherine Berris, “Siting of Salmon Farms” (TAT discussion paper) in Volume 3, for a detailed analysis of siting issues.

Table 12: Existing Measures Used to Make Salmon Farm Siting Decisions

I. Existing Siting Measures—General Effectiveness

Existing salmon farm siting policies and procedures are significantly more effective in preventing and mitigating adverse impacts than those in place in the early 1980s. During this time, decisions were often made without consideration of all relevant implications. Current siting provisions have incorporated lessons learned from that period and provide a significantly improved basis for making better siting decisions. Also, husbandry practices at farm sites have evolved to better account for the interests and perspectives of other coastal uses, resulting in fewer impacts and conflicts than were experienced in the 1980s. Despite this improving trend, some problems remain with existing siting policies and procedures, and with the current location of some sites that were approved under former policies. There are impacts on First Nations, recreation and tourism interests, prawn fishery opportunities, and some sensitive habitats. These are discussed below.

A. First Nations

The issues pertinent to First Nations are addressed in more detail in Chapter 9 of this volume. First Nations people are highly concerned about aquaculture in their traditional territories and, as detailed in Volume 2, of this report, those consulted during the review have expressed “zero tolerance” to salmon farming. They indicate that their interests are not being adequately served by the current decision-making process for salmon farm siting, despite recent attempts for greater involvement of First Nations in tenure decisions. Farms on tenures issued prior to the adoption of processes designed to fully consult regarding aboriginal rights are the source of much concern. The level of concern probably reflects inadequate process at that time.

In 1993, a MOU was executed between the province and the KTFC. It outlines a process for notice of and consultation regarding tenure issuance in the regions of the province claimed by Kwakiutl nations as traditional territories (Broughton Archipelago). This process has been applied to issuance of shellfish tenures, but has not been tested on salmon farming tenures. This agreement is in place until replaced by another protocol or agreement.

The Clayoquot Sound Interim Measures Extension Agreement between the Province and certain First Nation bands on Vancouver Island’s west coast is in effect until 1999. It describes a process of referral to the First Nation directly affected as well as to the Central Region Board (see Volume 2 for an outline of the process). The current policy of the MELP with respect to consultation to avoid potential infringement of aboriginal rights due to activities in Crown land was documented and released in early 1995, although it has been evolving since 1988. Although the MELP policy requirement is to refer salmon farm applications to First Nations where a proposed farm is within one kilometre of a First Nations reserve, it was determined through the information presented to the SAR that salmon farm applications during 1980—1988 were approved by MELP in the absence of First Nations comment on siting applications. The strong concerns by First Nations about salmon farms and the procedures that are followed for their approval indicates that the mechanisms for involving First Nation peoples in siting decisions needed reform from that period of time, in keeping with the newer models of consultation and participation. Government is obligated to consult with First Nations to determine whether or not a proposed activity would interfere with aboriginal rights and base decisions on that determination.

The SAR heard strong concerns from First Nations that fish farms had the potential to affect wild fisheries resources such as herring spawning habitat and locations where fish school when leaving and returning to streams. Particular concerns were raised that fish farms located near shellfish beds, harvested for social, ceremonial and sustenance purposes, were tainting those shellfish, thus preventing First Nations access to some traditional food supplies. The current policy requires that salmon farms be located 125 metres from shellfish beds; however, deposition from fish farms is known to occur at greater distances. Local water

currents and individual farm practices can significantly affect deposition rates and impacts, suggesting that the current siting guideline aimed at protecting shellfish resources is not especially effective in achieving its purpose.

There are questions regarding siltation and shellfish tainting. Although a small portion of feed is medicated (about 2 per cent in 1995) to treat sick farmed salmon, the antibiotics can enter clams and other sea life at distances beyond 125 metres from the salmon farm. It can take many days for these antibiotic residues to disappear. This raises an important question about appropriate distance

separation of salmon farms from shellfish beds, and the right of individuals to know whether or not the seafood that they may harvest has been exposed to antibiotics.

B. Recreation and Tourism

Some recreation and tourism interests report that existing mechanisms for approving salmon farm sites have resulted in sites being located where they negatively impact visual and amenity values. In the Broughton study area, the number of recreation sites affected by existing salmon farms ranges between 5 and 20 per cent, depending on the method of analysis and the type of recreation use. Half the larger recreation use areas and routes are highly or moderately affected by salmon farms. Most tourism operators in the study area report that salmon farm sites have had a negative impact on their operations in that area. This must be considered, however, relative to the overall performance of the coastal tourism sector in the Broughton which has had, and continues to have, substantial growth despite the presence of salmon farms.

The existing MELP salmon aquaculture siting policy does not explicitly identify protection of recreation and tourism values as a policy objective, and no salmon farm siting guidelines are officially in place to protect these values. Although there is an existing requirement to not locate salmon farms within the CRIS red zones (which indicate “no opportunity” for salmon farming, due in large part to important recreation and tourism values in those zones), the CRIS products and the way they are used are known to be flawed in several ways. Most significantly, a number of pre-existing site applications and tenures were allowed by MELP to locate within red zones. Additionally, CRIS mapping was conducted over a very short time period and does not necessarily incorporate all important recreation and tourism site and feature information. Recent recreation and tourism inventories of sites and features are not reflected in CRIS designations.

The MELP salmon aquaculture policy statement does not specify a requirement to avoid known boat anchorages or safe havens when siting salmon farms, but the standard operating practice is to do so when issuing tenures.

Since formation of the Vancouver Island Fish Farm Review Committee (a regional, inter-agency group that jointly considers salmon farm licensing issues), information on scenic values is said to now be influencing salmon aquaculture siting decisions.

Overall, information assembled during the SAR indicates that current policies and practices for preventing conflicts between salmon farms and recreation and tourism values are improving over what they once were. There continues, however, to be a lack of explicitness in the procedural requirement to consider and protect key recreation and tourism resources when evaluating salmon farm siting applications. This has resulted in inconsistent treatment of recreation and tourism values in siting decision-making.

C. Prawn Fishery

Another resource use that has been somewhat impacted by the way that salmon farm siting decisions are made is prawn fishing. A number of salmon farms in the Broughton area preempt what are regarded by local fishers as prime prawn fishing areas. The existing MELP salmon aquaculture policy does not specifically identify important prawn fishing grounds as areas to avoid when adjudicating salmon farm tenure applications. CRIS red zones may, however, protect some of

these sites, and the recent siting practice is to avoid physical conflict with trap fishery sites in cases where the location of those sites is known to the federal DFO.

There is little or no information about potential impacts from salmon farming on the prawns themselves.

D. Sensitive Habitats

Although the existing MELP siting policy does not contain a complete list of the sensitive environmental resources that must be avoided when making salmon farm siting decisions, actual MELP referral practices and aquaculture development plan review procedures appear to be relatively effective in preventing significant adverse siting impacts on these values. The administrative practice is to prevent siting farms near marine bird colonies or in close proximity to known seal or sea lion haul-outs. Herring spawning areas, wild fish rearing areas or important wild fish migration routes are typically identified by DFO when providing referral comments to MELP on salmon farm site applications. Besides, sensitive fisheries habitats such as eel grass beds, kelp beds, estuaries or herring spawning areas are normally in shallow waters that do not make for good salmon farming sites, and conflicts with these resource values should be accordingly prevented.

Even though impacts from salmon farming on sensitive habitats appear to be limited, there have been no comprehensive studies to identify the degree of overlap between existing salmon farms and sensitive fish and wildlife habitats. The SAR did receive anecdotal information through open houses and submissions that such impacts are occurring, and a preliminary assessment of salmon farms in Clayoquot Sound shows that there is some degree of overlap between salmon farms and other sensitive habitat values. Again, this may reflect the fact that those farms were sited under former policies and practices which were less rigorous and relied on a lower standard of information than do current approaches.

Finally, some existing salmon farms are known to cause negative impacts to sediments and resident marine organisms that are directly beneath or nearby net-cages, due to deposition of waste feed and fish faeces. Although areas beneath cages no doubt provide habitat for various marine lifeforms, with appropriate site information, 'sensitive habitats' would be avoided.

At a minimum, provincial siting policies need to be more explicit in the criteria that are to be applied in efforts to protect sensitive habitat values.

E. Other Resource Values and Interests

Siting policies and procedures have been generally effective in preventing or mitigating impacts on other resource values and users. For example, direct effects of salmon farms on commercial and sport fish locations appear to be low, mainly because of the large geographic

area used by these fishers in relation to the area occupied by salmon farms. Salmon farms may have had some impacts on archaeological resources, due to lack of site specific assessment and good inventory information, but these are thought to be few in number. Additionally, although the effects of salmon farm siting on navigation have not been quantitatively evaluated, it is expected that these are limited.

In summary, existing siting mechanisms have been partially effective in preventing and mitigating localized impacts and conflicts from salmon aquaculture development on aquatic Crown land. Improvements are needed to clarify the “rules” for making siting decisions, and to ensure that these are followed consistently. Current siting guidelines fail to adequately define the resource conflicts that are to be avoided. There are no defined requirements to identify and avoid environmentally sensitive areas, wildlife areas, and areas used by red- or blue-listed species. There are no siting guidelines that specifically take into account important recreation and tourism values. The CRIS designations that are presently an important underpinning of siting decisions are not based on the best available information on the location and relative importance of coastal resource values, and farms have been allowed to locate in “no opportunity” CRIS red zones. Finally, as “policy guidelines” the existing siting criteria are discretionary, and this has led to inconsistencies in their implementation. Siting criteria must be more explicitly defined and policy direction is needed to differentiate which criteria must be followed strictly versus those where some discretion is appropriate.

Although the practices and administrative systems for making siting decisions have improved in recent years, the majority of existing farms were sited in the late 1980s and early 1990s before many improvements were adopted. A review of existing sites to correct localized problems caused by poor original site selection is needed.

II. Referral Systems and Land Use Planning

Referral of salmon farm site applications to other agencies and interests is used currently by MELP as a main means of detecting potential salmon aquaculture siting impacts and conflicts. Information provided by referral contacts allows MELP to interpret whether or not a particular application should proceed. Given the central role of the referral system in making salmon farm siting decisions, it is essential that it should work effectively and efficiently. It has been demonstrated through the SAR, however, that there are some significant weaknesses both in how the existing referral system is administered and in the general ability of referral systems to consider applications in a broad enough context.

The SAR heard concerns that the MELP referral process is frequently implemented in an inconsistent and arbitrary fashion. While the MELP policy identifies a comprehensive list of agency, First Nations and interest groups that are sent referrals, historically, comments were not uniformly received from all referral contacts, notably First Nations. The lack of

consistent contact procedures indicates a general weakness in the overall referral-based approach to decision-making. The system can operate effectively and efficiently only if all appropriate contacts receive a referral, and if the participants supply timely referral comments. If this does not happen, then decisions are made in the absence of full information.

A significant weakness in the current referral system is that there is no obligation on MELP to act upon the referral comments they receive, or to provide an explanation of how referral comments were applied in siting decisions. MELP's role is to make "on balance" site application approval or disallowance decisions, based on a synthesis of all information that is assembled throughout the application process. MELP staff have considerable leeway in this role—neither the Land Act nor the salmon aquaculture policy that staff follow and apply, provide guidance or criteria for making tenuring decisions when there are competing or opposing referral comments. Staff must regularly make difficult siting decisions in the face of conflicting advice from referral contacts.

Given this extent of administrative discretion, it might be expected that relatively sophisticated notification procedures and decision review and appeal procedures are in place as a check and balance on MELP's discretionary powers. In fact, these procedures do not exist. The SAR heard complaints from both industry representatives and interests opposed to salmon farming that the MELP referral process and decisions resulting from it are unfair. Addressing siting disputes is discussed in Chapter 12.

Since imposition of the existing moratorium on issuing new salmon farm site tenures, an inter-agency committee (known as the Vancouver Island Fish Farm Review Committee)² has been established to deal with salmon farm tenure replacement and aquaculture licensing decisions. It is reported that this arrangement of face-to-face interagency communication on salmon aquaculture issues is working well. A committee structure of this nature:

- provides a forum for coordination among key agencies,
- encourages a greater degree of accountability of MELP land administration staff to be responsive to agencies' comments,
- encourages the development of expertise in approaching tenure issues,
- encourages inter-agency consensus-building on tenuring and licensing issues,
- encourages dispute resolution within the committee,
- encourages a closer link between government policy on salmon aquaculture and consistent application of the policy, and

- allows for salmon farming applications to be considered in groups, which may improve efficiency and timeliness of siting and management decisions and allow agencies to consider applications in a wider context, than on a site by site basis.

For these reasons, it is suggested that an inter-agency committee approach to making salmon farm siting and licensing decisions should be continued and formalized, as a replacement to conventional referral practices with referrals being sent to those agencies which do not wish to participate on the committee. Committees modelled after the existing Vancouver Island committee could be setup in other administrative regions with a mandate to decide on tenuring and licensing applications. They could meet regularly at pre-set times to consider applications in batches. They could also take responsibility for pre-identification of suitable salmon farming sites and the subsequent disposition of those sites through a competitive process (see below). It will continue to be necessary for statutory decision-makers to fulfill their legal decision-making obligations, but the decisions-makers could rely heavily on the committee views and consensus. Disagreements among the provincial agencies on the committee could be forwarded for resolution to the appropriate regional “Inter-agency Management Committee,” comprising more Senior Regional Managers. Disagreements at that level could be referred to the appropriate Assistant Deputy Ministers or Deputy Ministers for final resolution.

2 *Chaired by BC Lands and comprised of representatives from (MELP), Environmental Protection Program and Fisheries Program; (MAFF), Licensing, Inspection and Field Services Section; Ministry of Small Business, Tourism and Culture (MSBTC); Department of Fisheries and Oceans (DFO); and Environment Canada, Environmental Protection Service.*

Consultations with First Nations with respect to aboriginal rights are discussed in Chapter 9. Given the broader role recommended for First Nations in resource planning and management recommended in Chapter 9, First Nation representatives should be invited to join the Fish Farm Review Committee (FFRC) when an application is made in the traditionally claimed territory of that First Nation. Data and information on traditional uses are the basis for the determination regarding aboriginal rights. This committee will be establishing biophysical resource inventory requirements and with First Nation representation on the committee, information collection for First Nations consultation could be coordinated with the collection of other data sets. Collection of data to evaluate potential fisheries conflicts (including shellfish resources) and sensitive habitat assessment will greatly assist in assessing aboriginal rights.

Local government representatives for the area in which a tenure application is being considered should also be invited to the committee as a member, but also to serve as a liaison between this committee and the local advisory working committee discussed below (6.0 Public Consultation).

An additional shortcoming of site-by-site referrals as a primary basis for making salmon farm siting decisions is that they tend to restrict proponents' and agencies' attention to the characteristics of a single site and the immediate vicinity. There is little if any consideration given to the merits of the proposal from a regional or sub-regional perspective. When focusing at a site-specific level, it is difficult to appreciate the pros and cons of a proposal in terms of the relative importance of resources being affected. Bigger picture supply and demand relationships cannot be assessed, and it is not easy to consider the cumulative impact of multiple developments over time.

A superior arrangement for making salmon farm siting decisions is to prepare integrated coastal zone plans, where the relative capability and suitability of resource values and uses, across a region or sub-region, are considered in relation to demand for various resources, and where all interested parties have an opportunity for input into the designation of appropriate zones for particular purposes, including salmon aquaculture. Once approved, land use plans at the regional, sub-regional or local levels express a corporate land use policy that provides essential direction to individual siting decisions.

Figure 11. Proposed Salmon Aquaculture Review Process—Tenure (Land Act)

Figure 11 shows the salmon farm site application process in relation to the role of the FFRC and other institutions for First Nations participation in siting decisions.

The FFRC should be involved with salmon farm siting decisions, and also significant management decisions such as the review and approval of operational plans. Their role should extend to decisions on initial applications, applications for tenure replacement and applications for substantial increase in site size (i.e., expansions of greater than 50 per cent of the tenure area).

Very little planning of this type has occurred to date for coastal areas in B.C. A few integrated management plans have been developed, such as in Barkley Sound on Vancouver Island's west coast, and some local governments have regulated salmon aquaculture uses in their jurisdictions through the general land use control powers granted to local governments under the provincial Municipal Act. Most recently, two strategic level land use plans (Central Coast and Queen Charlotte Land and Resource Management Plans—LRMP) are being initiated, and it is expected that these processes will produce some broad management direction for areas of the coast that are within the planning study boundaries. The several CRIS plans that have been prepared for selected coastal areas cannot be said to be "integrated coastal zone management plans," as they are not based on capability or suitability assessments for salmon aquaculture or other uses, and do not provide prescriptive direction on land and resource management priorities.

While existing referral mechanisms provide for a threshold level of integration and multiple use of B.C.'s coastal resources, this approach needs to be supplemented with comprehensive coastal zone planning. Trends in this direction should be encouraged and expanded. The process of planning provides for, and encourages participation by, many levels of government, agencies within governments and non-government organizations and individuals. Generally, resource planning recognizes the zoning or land use bylaws adopted by local governments. Where a provincial level plan has recognized local government zoning in a plan, it is highly unlikely that the Minister of Agriculture, Fisheries and Food would exercise power under the Farm Practices Protection Act to vary these bylaws. The planning exercise provides a good mechanism to resolve conflict at a high level.

The preparation of integrated coastal zone plans for all areas of B.C. may be some time away, given the cost and time requirements of this type of planning. Also, it is probable that coastal zone management plans, at least those at the sub-regional level, will not be so prescriptive that particular salmon farm sites are identified as a result of the plans. It may be, however, that there are opportunities to introduce measures to realize the benefits of integrated planning without going through a full scale planning exercise. A process that focuses on salmon farming, but which promotes integrated planning principles, could be adopted. For example, suitable salmon farming sites could be pre-selected and then marketed by government, as opposed to the reactive assessment of individual siting proposals. This could allow for the concurrent consideration of other resource values and demand for those values. Opportunities could be provided for input from key agencies, local governments, First Nations and interest groups.

The pre-identification of suitable areas and a call for proposals for sites would allow government to assess proposals using a range of criteria. For example, winning proposals might be those that demonstrate a commitment to sound environmental management through the use of best available technology and management practices, and which provide local training and employment opportunities. Since First Nations people are often a large component of coastal communities, commitments to these communities could be encouraged through this process. Other evaluation criteria could be considered, on a site by site basis, such as whether or not the proposal involved a joint venturing arrangement with First Nations partners, or a commitment to process the farmed fish to a range of value added products in a particular community. This approach would allow government to proactively prevent and mitigate siting issues, and at the same time achieve local social or economic development objectives as well as achieve fair value for the resource rent. The development of sub-regional coastal zone management plans that identify geographic zones that are appropriate for salmon farming would complement this approach by providing a focus for the pre-identification of specific suitable sites.

III. Siting Criteria

Province-wide siting guidelines have been used as a primary tool for locating salmon farms. The existing guidelines, described in Chapter 3, are designed to prevent conflict and impact, mainly through the separation of salmon farming from sensitive or incompatible resources or uses. The

first section of this chapter described how these criteria are deficient in that some of them are ambiguous in their intent, there are no guidelines to protect certain resource values, and they have been applied inconsistently.

To respond to these issues, the siting criteria shown in Table 13 are proposed as a replacement to the existing salmon farm siting guidelines. They are aimed at two basic objectives:

- *to locate salmon farms at sites with intrinsic biophysical capability and socio-cultural suitability, in order to prevent or reduce negative impacts and conflicts, and*
- *to promote successful production of healthy farmed salmon.*

These siting criteria should be used in areas where there is not a coastal zone management plan (or local zoning bylaw) that provides sufficiently detailed siting direction, and in areas where government has not already conducted an “interim” planning process to pre-identify suitable salmon farming sites as a basis for competitive allocation of those sites. The siting criteria proposed in Table 13 would be applied to new tenure sites if the existing moratorium on applications is lifted, at least in certain geographic areas of the coast.

Table 13: Recommended Salmon Farm Siting Criteria

RESOURCE / INTEREST TO BE MAINTAINED	SITING OBJECTIVES	SITING CRITERIA	INFORMATION AND RESEARCH PRIORITIES	MANDATORY CONSULTATIONS IN APPLYING CRITERIA
1. Wild Salmon Stocks	<ul style="list-style-type: none"> Reduce risks to wild salmon, especially risks of colonization, genetic dilution, habitat competition and disease transfer. Reduce risks of disease transfer from wild to farmed fish and from farmed to wild. 	<ul style="list-style-type: none"> No salmon farms within 1 km radius from the mouth of all anadromous fish streams. 	<ul style="list-style-type: none"> Identify streams through combined provincial/federal stream surveys and classification processes. Classify the degree of importance and vulnerability of anadromous fish streams. Conduct research into the risks (e.g., colonization, habitat impact, disease transfer risks) that salmon farms present to anadromous fish, as basis for confirming or amending this criterion. 	<ul style="list-style-type: none"> DFO MELP First Nations Local interests
2. Herring Spawning Areas	<ul style="list-style-type: none"> Reduce risk of impact on key herring spawn habitat (e.g., impacts caused by noise, vibration, light). 	<ul style="list-style-type: none"> No salmon farms within 1 km of herring spawning areas designated as "vital," "major" or "important" (DFO classification), with DFO and local consultation required where salmon farms are proposed within areas classified as "sometimes important" or "minor" to determine if standards apply. 		<ul style="list-style-type: none"> DFO, First Nations, and local fishers (as described)

Table 13: Recommended Salmon Farm Siting Criteria

RESOURCE / INTEREST TO BE MAINTAINED	SITING OBJECTIVES	SITING CRITERIA	INFORMATION AND RESEARCH PRIORITIES	MANDATORY CONSULTATIONS IN APPLYING CRITERIA
11. Recreation and Tourism	<ul style="list-style-type: none"> Maintain the number and quality of key (i.e., high value / high use) recreational and tourism sites (such as beach campsites, good anchorages, and special wildlife viewing areas). Maintain the quality of recreational and tourism experiences, while allowing some flexibility for the coexistence of recreational / tourism uses and salmon aquaculture activities. 	<ul style="list-style-type: none"> No salmon farms at sites that are "important" for recreation and tourism purposes, as defined through reference to CRIS data, Tourism Resource Inventories, and consultation. Locate salmon farms an appropriate distance from "other" recreation and tourism sites, as determined through reference to CRIS data, Tourism Resource Inventories and consultation (i.e., "other" sites are those that have value and/or are used for recreation and tourism purposes, but which are not classified as "important"). 	<ul style="list-style-type: none"> Inventory, map and classify recreation and tourism sites and features, as basis for enabling identification of the relative "importance" of recreation and tourism sites and features. 	<ul style="list-style-type: none"> MSBTC MOF, Recreation Marine Trails Association Other recreation organizations Local tourism operators Other local interests
12. Fisheries Conflicts	<ul style="list-style-type: none"> Maintain opportunities for fishers to access key areas and sites that are essential for their operations. 	<ul style="list-style-type: none"> No salmon farms in areas that would preempt important aboriginal, commercial, or recreational fisheries (e.g., seine tie-up spits, gillnet drift areas, trap fishing areas, traditional trawl sites, shrimp and prawn areas). 	<ul style="list-style-type: none"> Identify or confirm and map important locations for various fisheries. 	<ul style="list-style-type: none"> DFO First Nations Local fishers MELP/MAFF
13. Cultural and Heritage	<ul style="list-style-type: none"> Protect the integrity of cultural heritage resource values, in compliance with legislative requirements. 	<ul style="list-style-type: none"> Locate salmon farms in conformance with the requirements of the <i>Heritage Conservation Act</i>, based on consultation with MSBTC (Archaeology Branch). 	<ul style="list-style-type: none"> Inventories and mapping of archaeological sites and cultural heritage values. 	<ul style="list-style-type: none"> MSBTC, Archaeology Branch
14. Land Use Planning and Zoning Designations	<ul style="list-style-type: none"> Recognize local government authority and accountability to control salmon aquaculture siting decisions, based on local priorities and preferences avoid ongoing resource use conflict. 	<ul style="list-style-type: none"> Site salmon farms in full accordance with approved local government land use / zoning bylaws. 		<ul style="list-style-type: none"> Appropriate Regional District

RESOURCE / INTEREST TO BE MAINTAINED	SITING OBJECTIVES	SITING CRITERIA	INFORMATION AND RESEARCH PRIORITIES	MANDATORY CONSULTATIONS IN APPLYING CRITERIA
<p>6. Waste Assimilation / Dispersion</p>	<ul style="list-style-type: none"> Locate salmon farms at sites with high intrinsic capability to assimilate and disperse organic waste discharges from salmon farms, thus preventing benthic impacts, minimizing the potential for costly impacts to operators, and facilitating the likelihood of continuous farmed fish production at the site (i.e., eliminating or reducing the need for site fallowing). 	<p>As guidelines:</p> <ul style="list-style-type: none"> Locate salmon farms in areas that are naturally well-flushed by tides and currents and do not experience heavy natural organic deposition or natural oxygen depletion. Ideally, currents should be predominantly offshore or parallel to shore, and average current speeds should be >10, >5, and >3 cm per second at the surface, mid-depth and bottom, respectively. Natural bottom conditions beneath net-cages should not be more than 70% fine silts and clays. Water depth should be > 30 metres with bottom sloping offshore; or > 20 metres at locations where sediments will not accumulate due to high tidal flushing. 	<ul style="list-style-type: none"> overtime incorporate detailed current data into computer site modelling. 	
<p>7. Navigation / Safety</p>	<ul style="list-style-type: none"> Prevent interference with marine navigation safety and the operation of federal boating facilities. Prevent interference of public access to Crown shoreland. Prevent interference with marine navigation safety and prevent conflicts with commercial fishers and recreational boaters. 	<ul style="list-style-type: none"> Comply with all requirements of the <i>Navigable Waters Protection Act</i>, as administered by the Canadian Coast Guard. As a guideline, maintain opportunities for boater access to shoreline which is not part of the <i>Land Act</i> site tenure. No salmon farms at marine anchorages designated on marine charts or by the CBCYC as boat havens. 		<ul style="list-style-type: none"> Coast Guard Council of BC Yacht Clubs (CYCBC) MSBTC

RESOURCE / INTEREST TO BE MAINTAINED	SITING OBJECTIVES	SITING CRITERIA	INFORMATION AND RESEARCH PRIORITIES	MANDATORY CONSULTATIONS IN APPLYING CRITERIA
<p>6. Waste Assimilation / Dispersion</p>	<ul style="list-style-type: none"> Locate salmon farms at sites with high intrinsic capability to assimilate and disperse organic waste discharges from salmon farms, thus preventing benthic impacts, minimizing the potential for costly impacts to operators, and facilitating the likelihood of continuous farmed fish production at the site (i.e., eliminating or reducing the need for site following). 	<p>As guidelines:</p> <ul style="list-style-type: none"> Locate salmon farms in areas that are naturally well-flushed by tides and currents and do not experience heavy natural organic deposition or natural oxygen depletion. Ideally, currents should be predominantly offshore or parallel to shore, and average current speeds should be >10, >5, and >3 cm per second at the surface, mid-depth and bottom, respectively. Natural bottom conditions beneath net-cages should not be more than 70% fine silts and clays. <p>Water depth should be > 30 metres with bottom sloping offshore; or > 20 metres at locations where sediments will not accumulate due to high tidal flushing.</p>	<ul style="list-style-type: none"> overtime incorporate detailed current data into computer site modelling. 	
<p>7. Navigation / Safety</p>	<ul style="list-style-type: none"> Prevent interference with marine navigation safety and the operation of federal boating facilities. Prevent interference of public access to Crown shoreland. Prevent interference with marine navigation safety and prevent conflicts with commercial fishers and recreational boaters. 	<ul style="list-style-type: none"> Comply with all requirements of the <i>Navigable Waters Protection Act</i>, as administered by the Canadian Coast Guard. As a guideline, maintain opportunities for boater access to shoreline which is not part of the <i>Land Act</i> site tenure. No salmon farms at marine anchorages designated on marine charts or by the CBCYC as boat havens. 		<ul style="list-style-type: none"> Coast Guard Council of BC Yacht Clubs (CYCBC) MSBTC

RESOURCE / INTEREST TO BE MAINTAINED	SITING OBJECTIVES	SITING CRITERIA	INFORMATION AND RESEARCH PRIORITIES	MANDATORY CONSULTATIONS IN APPLYING CRITERIA
11. Recreation and Tourism	<ul style="list-style-type: none"> Maintain the number and quality of key (i.e., high value / high use) recreational and tourism sites (such as beach campsites, good anchorages, and special wildlife viewing areas). Maintain the quality of recreational and tourism experiences, while allowing some flexibility for the coexistence of recreational / tourism uses and salmon aquaculture activities. 	<ul style="list-style-type: none"> No salmon farms at sites that are "important" for recreation and tourism purposes, as defined through reference to CRIS data, Tourism Resource Inventories, and consultation. Locate salmon farms an appropriate distance from "other" recreation and tourism sites, as determined through reference to CRIS data, Tourism Resource Inventories and consultation (i.e., "other" sites are those that have value and/or are used for recreation and tourism purposes, but which are not classified as "important"). 	<ul style="list-style-type: none"> Inventory, map and classify recreation and tourism sites and features, as basis for enabling identification of the relative "importance" of recreation and tourism sites and features. 	<ul style="list-style-type: none"> MSBTC MOF, Recreation Marine Trails Association Other recreation organizations Local tourism operators Other local interests
12. Fisheries Conflicts	<ul style="list-style-type: none"> Maintain opportunities for fishers to access key areas and sites that are essential for their operations. 	<ul style="list-style-type: none"> No salmon farms in areas that would preempt important aboriginal commercial, or recreational fisheries (e.g., seine tie-up spits, gillnet drift areas, trap fishing areas, traditional trawl sites, shrimp and prawn areas). 	<ul style="list-style-type: none"> Identify or confirm and map important locations for various fisheries. 	<ul style="list-style-type: none"> DFO First Nations Local fishers MELP/MAFF
13. Cultural and Heritage	<ul style="list-style-type: none"> Protect the integrity of cultural heritage resource values, in compliance with legislative requirements. 	<ul style="list-style-type: none"> Locate salmon farms in conformance with the requirements of the <i>Heritage Conservation Act</i>, based on consultation with MSBTC (Archaeology Branch). 	<ul style="list-style-type: none"> Inventories and mapping of archaeological sites and cultural heritage values. 	<ul style="list-style-type: none"> MSBTC, Archaeology Branch
14. Land Use Planning and Zoning Designations	<ul style="list-style-type: none"> Recognize local government authority and accountability to control salmon aquaculture siting decisions, based on local priorities and preferences avoid ongoing resource use conflict. 	<ul style="list-style-type: none"> Site salmon farms in full accordance with approved local government land use / zoning bylaws. 		<ul style="list-style-type: none"> Appropriate Regional District

Table 13: Recommended Salmon Farm Siting Criteria

RESOURCE / INTEREST TO BE MAINTAINED	SITING OBJECTIVES	SITING CRITERIA	INFORMATION AND RESEARCH PRIORITIES	MANDATORY CONSULTATIONS IN APPLYING CRITERIA
1. Wild Salmon Stocks	<ul style="list-style-type: none"> Reduce risks to wild salmon, especially risks of colonization, genetic dilution, habitat competition and disease transfer. Reduce risks of disease transfer from wild to farmed fish and from farmed to wild. 	<ul style="list-style-type: none"> No salmon farms within 1 km radius from the mouth of all anadromous fish streams. 	<ul style="list-style-type: none"> Identify streams through combined provincial/federal stream surveys and classification processes. Classify the degree of importance and vulnerability of anadromous fish streams. Conduct research into the risks (e.g., colonization, habitat impact, disease transfer risks) that salmon farms present to anadromous fish, as basis for confirming or amending this criterion. 	<ul style="list-style-type: none"> • DFO • MELP • First Nations • Local interests
2. Herring Spawning Areas	<ul style="list-style-type: none"> Reduce risk of impact on key herring spawn habitat (e.g., impacts caused by noise, vibration, light). 	<ul style="list-style-type: none"> No salmon farms within 1 km of herring spawning areas designated as "vital," "major" or "important" (DFO classification), with DFO and local consultation required where salmon farms are proposed within areas classified as "sometimes important" or "minor" to determine if standards apply. 		<ul style="list-style-type: none"> • DFO, First Nations, and local fishers (as described)

Whether or not a land use plan is in place, and even if a site proposal meets the proposed siting criteria in Table 13, a more detailed site-specific assessment of conditions and characteristics in the vicinity of the site should be required as a basis for making a final siting decision. The envisioned way that the proposed siting criteria should be applied relative to approved land use plans and detailed site assessments is shown in Figure 12. Where sites are preselected by government, resource assessment should be done to achieve the siting objectives defined in Table 13, with assessment costs recovered through resource rent for the site.

As can be seen from Table 13, a number of the proposed siting criteria specify distances that salmon farms must be separated from other resource values, as a strategy for preventing or mitigating impact and conflict. These distances are judgements made by the advisors on the TAT. There is no definitive scientific evidence to say that these are the precise distances that salmon farms should be separated from the identified resource values in order to absolutely prevent or mitigate impact and conflict. In the face of this uncertainty, and given the need to reduce impact and risk of impact on important resource values and the users of those resources, it is proposed that these distance criteria be implemented as strict minimum standards, not as discretionary guidelines. In fact, site-specific assessment may suggest that greater distance separation is needed in some cases to avoid anticipated negative impacts. It is intended that future monitoring and research into the effectiveness of the proposed siting criteria in meeting their intended aim, and their effect on the industry, will provide a basis for either confirming or adjusting the criteria.

Figure 12. Application of Proposed Siting Criteria

Schedule Easement Proposal
• Schedule items after proposal received?

Land Use Plan
• Is Land Use Plan to place that provides along direction?

Consistency with Plan
• Is schedule iteming at proposed location consistent with Land Use Plan?

Apply Signs Criteria
• Does proposed also satisfy signing criteria?

Display Proposed Sign

Detailed Site Assessment
• Based on site specific information, can impacts/benefits be generated or mitigated?

Site Approval
• Issues site location and agricultural license

→

YES

NO

NO

NO

YES

YES

NO

YES

The proposed siting criteria have been formulated on the basis of conventional salmon aquaculture net-cage technology. As salmon farming technology and practices change, the criteria will require re-evaluation. The siting criteria would require review and change for siting of “offshore” technology where navigational hazards associated with siting take on greater significance (refer to Chapter 11).

IV. Technical Information Supplied by Applicants

At present, site applicants are required to supply MELP with certain information on the characteristics of the proposed site and the intended use. Agencies consider this and other information when adjudicating site tenure and aquaculture license applications. To acquire detailed information on site characteristics, applicants typically obtain a six-month investigative permit that authorizes them to go onto Crown land to undertake studies of the site’s suitability for salmon farming use, and to identify other resource values at and in the vicinity of the site.

Information that the applicant supplies is often quite general. The current salmon aquaculture development plan ‘questionnaire’ that accompanies an application for a site tenure takes the form of a series of boxes that are checked off by the applicant to indicate the presence or absence of particular resource values at or near the proposed site. More specific information than that submitted by the applicant is typically needed. Agencies acquire this through a variety of sources including referrals, reference to government mapping and inventories, field inspections, and public responses to newspaper advertisements of the application.

As indicated earlier, the SAR heard concerns about this existing approach, including perceptions of inconsistency, arbitrariness in what information is considered by management agencies when making siting and licensing decisions, and slowness in application processing.

An alternative that management agencies should consider in efforts to address these concerns is to require applicants to submit a complete package of information needed by agencies to make informed site tenure and licensing decisions.³ Applicants could assemble the information from available government inventories and mapping, site surveys, and through consultation with local interests. If done properly, this will eventually reduce the current bureaucratic practice of referring

³ This requirement would not apply where government proactively identified and marketed salmon farm sites following an “interim” planning process see Section II above.

site tenure applications to a spectrum of other interests as a main basis for adjudication decisions, especially if an inter-agency FFRC forum is used to make siting decisions.

From government's perspective, the submission of a detailed site assessment by the applicant would mean that the costs of collecting site information through referrals, field inspections and public advertisement would be transferred substantially to the applicant ("user pay" principle, other than government's auditing costs). There are precedents for this approach. For example, development proponents that are subject to the provincial EAA bear all costs of collecting information that is needed by government to make a development approval or rejection decision.

This arrangement could also allow for greater consistency in policy implementation, provided that proponents are given clear direction on the type and quality of information that is expected to be submitted, and access to government information sources such as coastal resource data that is housed in the corporate Coastal Information and Inventory System (CIIS). The local working committees should develop the type and level of site assessment data required in consultation with First Nations, governments and other interested agencies.

Guidelines are needed to describe what is required in a site application. Some of the information contained in an application could include:

- a description of the proposed farm, providing details on the specific tenure requested, including a sketch of the site and proposed development plan,
- an explanation of the range of operational use for the site and general description of the configuration of the infrastructure at the site,
- a description of the biophysical characteristics of the site, as well as current and bathymetric conditions (data of this type should be provided for an area some distance beyond the edge of the tenure applied for, as agreed to by the regional lands manager, to provide appropriate contextual information,
- an explanation of how the siting criteria outlined in Table 13 would be met by the proposal, and
- a general description of the workforce and onshore infrastructure and service needs of the project.

From the applicant's perspective, although there would be costs associated with information collection, this approach would allow for improved control on the timing of application processing. The applicant would not be held-up waiting for government to assemble and evaluate the necessary information. This could be a considerable advantage in today's climate where administrative resources in provincial offices are substantially reduced compared to past levels.

V. Government Inventories and Mapping

Inventories and maps of natural resource values and human uses of natural resources are essential for:

- integrated coastal zone planning (and interim processes which may approximate such planning), and
- the informed consideration of individual salmon farm site applications.

The benefits of good inventory and mapping information are many. It enables salmon farm proponents and resource managers to anticipate and prevent adverse impacts. With sound knowledge of the location and relative importance of resources and resource uses, a siting proposal may be confidently approved because it is known to be at a site that is generally suitable for the intended use, or it may be disallowed because it will cause known impacts or conflicts. Good inventory and mapping contributes to integrated/multiple use management of coastal resources because decisions can be made with greater precision—the location, quantity and quality of resources and human uses are objectively known, and environmental tolerances and thresholds are better understood. Good inventory information also enables improved equity and fairness in decision-making because greater consistency in decision-making is ensured and a more objective basis for decision-making is established. Finally, although it is expensive for governments to collect, map and maintain resource inventory systems, there are cost-savings to both coastal users and government as a result of more expeditious decision-making, and through decision-making that does not lead to controversial and costly impacts and conflicts after the fact.

In recent years, government has responded to the need for more comprehensive and accurate biophysical and socio-cultural inventories. Substantial investments have been made in the provincial Terrain Resource Inventory Mapping (TRIM) base mapping program, the Resource Inventory Committee (RIC) program to establish consistent inventory and mapping standards, and the Corporate Resource Inventory Initiative (CRII) program to actually assemble and map various resource themes in specific geographic locations. Most recently, the CIIS has emerged as the province's single, integrated data set for coastal resource information. It includes information for substantial areas of B.C.'s coastline on biophysical values such as fish and wildlife habitat, and socio-cultural information such as significant use areas and sites with special designations. This information base should prove to be immensely important in future efforts to plan and manage B.C.'s coastal zone, including the resolution of salmon aquaculture siting issues. Given the many potential uses and benefits of such information, ongoing inventory, mapping and system development initiatives at the provincial and federal levels should be strongly supported in both the short and long term.

A particular application of the emerging CIIS system in contributing to the prevention of salmon farm siting conflicts would be the preparation of salmon aquaculture suitability mapping for B.C.'s coastline, where geographic areas are ranked according to their relative potential for salmon aquaculture use. Biophysical and social factors could be considered in preparing the mapping, which would be valuable for advising salmon aquaculture proponents

on which coastal locations have the highest intrinsic suitability for salmon aquaculture, and as an important information input into coastal zone planning and “interim” planning processes.

VI. Public Consultation

At present, opportunities for public input into salmon farm siting decisions are relatively limited. Salmon farm applicants are required to run an advertisement in local newspapers indicating their intent to apply for a disposition of Crown land and inviting interested parties to submit comments to MELP. A few organizations, such as the CBCYC and the British Columbia Wildlife Federation (BCWF), are standard referral contacts, and have the opportunity to submit written comments on siting proposals for consideration.

Wherever land use plans are in place that contain direction on salmon farm siting, the planning process itself will have included some degree of opportunity for public input into plan development, but this opportunity is not related to specific salmon farm siting proposals. CRIS maps were built largely through coastal user groups plotting their ‘valued resources’ onto maps, but again that opportunity was unconnected to any specific siting proposal.

Previous recommendations in this chapter should enhance opportunities for public participation in salmon farm siting. However, an option that government should consider in expanding opportunities for direct public participation in siting decisions is to establish local advisory “working committees.” The committees should comprise a balanced cross section of local interests in salmon farm siting issues, local government, recreational, tourism, environmental, salmon farming and other business interests. First Nations, as members of the local communities where salmon farming takes place, should be invited to sit on these committees, but this mechanism would not replace membership on the FFRC or consultative tools for purposes of assessing aboriginal rights. First Nations consultation and salmon farm siting questions are considered further in Chapter 9. The working committees should have a

mandate to provide input on salmon farm siting issues as well as to advise on salmon aquaculture licensing aspects such as the development of salmon farm management plans. The working committees should establish their rules of operation and determine a process to deal with public comment on an application.

To ensure that these committees operate cost-effectively, it would make sense to tie in with existing local committees that are already involved in other land or resource planning/management activities. For example, an existing LRMP Table sub-committee, Local Round Table, Community Resource Board, or Advisory Planning Commission might provide an effective forum for obtaining public comment on salmon aquaculture siting and management issues.

VII. Remediation at Existing Problem Sites

As stated previously, a number of existing salmon farm sites were approved under former siting practices that were less rigorous than present (and proposed) measures for anticipating and preventing negative impacts and conflicts. Some farms were located in the absence of information on resource impacts and without sufficient consultation. Most were located prior to government's adoption of its "Crown Land Activities Policy," the memorandum of agreement with the KTFC and the establishment of the Central Region Board (all of which ensure a consideration of the question of aboriginal rights and potential infringement (see Chapter 9). The result is that some existing farms are causing undesirable impacts and

conflicts, due largely to inappropriate site selection. For example, some salmon farms are known to be located at relatively poorly flushed sites where farm sedimentation is negatively impacting the benthic community beneath the net-cages.

A review of existing salmon farm sites is needed to assess the degree of negative impacts and to identify the specific source of those impacts. Where it is determined that significant problems are occurring, a remediation plan should be developed. The plan might contain a variety of provisions, including measures to revise production levels, amend husbandry practices, incorporate different technology, or potentially relocate a farm to a more suitable location. To facilitate this, agencies (MAFF, MELP, DFO) should cooperatively establish a priority listing of farms to be assessed, taking into account past performance at the site, available site monitoring information, First Nations concerns, the amount of time remaining in the site tenure agreement, and agencies' capacities to perform the assessment. This is also discussed as a waste discharge issue in Chapter 7.

VIII. SITING SALMON AQUACULTURE FACILITIES IN FRESHWATER LAKES

Freshwater aquaculture facilities include land-based hatcheries and juvenile-rearing lake net-cages. Hatcheries utilize ground or surface water to hatch eggs and rear juvenile salmon in tanks to various stages of development. Hatchery effluent is discharged into moving water or wetlands. Lake-cage operations offer a cost-effective alternative to rearing juvenile salmon in hatcheries. Fry and juvenile salmon are moved to lake net-cages early in their development and are raised there until they reach the smolt stage and can be transferred to marine net-cages. Similar to marine net-cages, freshwater farms discharge effluent directly into the lake in which they are situated.

Wastes from hatchery operations are regulated by MELP under the authority of the Land-Based Fin Fish Waste Regulation under the Waste Management Act. It requires the owner to submit a water quality report before the facility is built that assesses the potential effects of the proposed waste discharges. The regulation also sets standards for the quality of effluent discharged from the facility. Waste discharge permits are also issued by MELP, but hatcheries may be exempt from this requirement if they comply with the conditions of the Land-Based Fin Fish Waste Regulation.

Hatcheries supplying the aquaculture industry must be licensed under the Fisheries Act. Those diverting surface water will require a water licence and those on provincial land extracting groundwater from a well at a rate greater than 75 l/s will require a project approval certificate for the extraction.

For the most part, freshwater net-cage operations are affected by the same regulatory framework as marine facilities. However, the requirements for siting freshwater farms are somewhat different. Individual lakes are assessed by MELP before net-cage operations are developed. The current criterion for approval of a facility in a lake is that the lake be low in nutrients and productivity, or "oligotrophic." Under this criterion five lakes have been approved for salmon farming. Two of these, Georgie and Lois Lakes on Vancouver Island, have active operations.

The issues associated with land-based hatcheries and freshwater net-cages are similar to those discussed for marine systems, however, the effects of certain aspects of salmon farming, namely waste discharges and escaped farm salmon, may be more significant in freshwater. The TAT concluded that due to the relatively closed nature of freshwater lakes, and the potential for escaped fish to outnumber indigenous populations, the likelihood that escaped farm salmon may adversely affect land-locked indigenous fish populations and successfully colonize is greater than for escapes from marine net-cages. Escapes from hatcheries has been raised as a concern, especially with respect to Atlantic salmon, but there is no evidence of survival (long-term) of any escapes in freshwater streams or rivers.

Similarly, the effects of waste discharges in lake systems are different from marine systems in magnitude and character because of the different physical characteristics and more isolated nature of freshwater lakes. For instance, the ability of a lake to assimilate wastes is much different than that of the ocean. Most coastal lakes in B.C. are oligotrophic, so that even minor inputs of phosphorus and/or nitrogen can cause significant impacts, potentially causing eutrophication. While freshwater systems are impacted by all of the various effects of waste discharges described for ocean systems, the TAT determined that they are particularly vulnerable to water column eutrophication resulting from increased nutrient (nitrogen and phosphorus) levels.

Although increased productivity has been identified as a potential effect of freshwater aquaculture development, it is not necessarily always a negative effect. Depending upon the circumstances, increased nutrification in oligotrophic or low productivity freshwater lakes can stimulate increased productivity, to the point of enhancing recreational or commercial fisheries. Government's role is to determine whether increased productivity would have a positive or negative influence on a particular lake and to assess the potential impact that escaped farm salmon might have on indigenous fish populations. Before any aquaculture development is approved, guidelines for making these lake-by-lake evaluations are needed to ensure that a consistent and thorough approach is followed in lake risk assessment. Draft guidelines are already in place. These need to be finalized and confirmed in policy as the basis for making decisions on salmon aquaculture facilities in freshwater lakes.

CHAPTER 5. ESCAPED FARM SALMON 1

As outlined in Chapter 2, commercial salmon farming in B.C. has several distinct operational stages, including egg incubation and hatching, initial rearing of young salmon in freshwater, and final grow-out in marine net-cages. At each of these stages, salmon may escape into the freshwater or marine environment. During 1994–1995, the reported annual escape was 61,996 farm salmon (57,846 Atlantic, 3,650 chinook, 500 coho).

The factors contributing to escaped farm fish include: deficient farm operations, weather (e.g., storm damage to net pens), predators, accidents (e.g., inadvertent release during transport), and vandalism. Overall, weather has been the most significant contributor to fish escapes. However, over time, the relative importance of weather has been declining and the primary factors contributing to farm salmon escapes in recent years have been farm operations and predation.

Historical changes in reported escape numbers indicate two distinct trends. First, the total numbers reported annually have declined from an average of approximately 185,000 fish per year between 1989 and 1991 to an average of approximately 27,300 fish per year during 1992–1996. Second, the species composition of escapes has changed significantly. While the overwhelming majority (99 per cent) of escapes during 1989–1991 were chinook salmon, by 1992–1996 most (65 per cent) were Atlantics. This reflects the steadily increasing proportion of overall production represented by Atlantic salmon.

The reported number of escaped farm salmon represents a minimum number. While salmon farmers are required to report fish escapes, typically only those large enough to be deemed of economic importance are actually reported. The numbers of farm salmon getting into the wild as a result of smaller escapes or “leakage”, that often go unnoticed and/or unreported, are difficult to estimate. However, the TAT noted that the number of escaped salmon resulting from chronic leakage could be equal to the number that are actually reported, thus potentially doubling the total number of escapes. An additional source of escaped Atlantic salmon is the commercial salmon farms in Washington State. Escaped Atlantics from those farms are undoubtedly entering and spending significant time in B.C. waters.

Salmon farmers are concerned about escaped farm fish. They have an economic incentive to keep their stock in the net-cages. This has led to techniques/operating practices designed to address the various underlying causes of escapes. For example, devices such as ADDs and predator nets are used to try and minimize predation and, hence, prevent escapes caused by predator damage to nets (refer to Chapter 8 for further details). Similarly, improved siting and farm design have enabled farms to reduce escapes resulting from damaged net-cages caused by storms.

Although it is in the best interests of salmon farmers to minimize or prevent escapes, and it appears that the trend is towards fewer escapes, many farm salmon still get out into the wild.

As a result, there are serious concerns relating to the potential negative effects of large numbers of escaped farm salmon on B.C.'s coastal resources. This has led to specific policies and regulations that form part of the existing aquaculture management framework.

I. EXISTING MEASURES TO PREVENT/MITIGATE ESCAPE EVENTS

Provincial controls of escaped farm salmon are outlined in the provincial Aquaculture Regulation, and the federal controls in the Fishery (General) Regulations adopted under the federal Fisheries Act. The provincial requirements are tied to the aquaculture licence, which is necessary for all commercial aquaculture operations. Non-compliance with the aquaculture licence can result in the licence being suspended, revoked or not re-issued.

A. Escape Prohibition/Prevention

The provincial Aquaculture Regulation is administered by MAFF. It specifically prohibits the release of fish from a salmon aquaculture facility unless the release is authorized by the aquaculture licence. It also requires a licence holder to take “reasonable precautions” to prevent accidental escape of farm fish, including the period of transportation from one facility to another. Failure to comply with the regulation is punishable as an offence under the Fisheries Act. The federal Fishery (General) Regulations prohibit the release of live fish to any fish habitat, unless the release is authorized under a licence issued by the Minister of Fisheries and Oceans. However, this is aimed at addressing the intentional release of fish rather than the unintentional escape of farm fish. In practice, aside from salmon farmers’ self-interest in preventing escapes, the provincial Aquaculture Regulation and the aquaculture licence are the primary management tools for the prevention of escapes.

B. Requirement to Report Escapes

Both MAFF and DFO require a salmon farm operator to report escape events, each from their jurisdictional perspectives. Under the Aquaculture Regulation, an aquaculture licence-holder is required to report any escape or evidence suggesting an escape to the provincial Aquaculture Manager, either verbally within 24 hours of discovery or in writing within one week of the discovery if requested by the Aquaculture Manager. Similarly, the Fishery (General) Regulations authorize DFO to require notification of any escape of farm salmon, first orally and then in writing. The written report must contain information regarding the location, the species and strain of fish, the cause of the accidental escape, the previous freshwater location of the fish, the size of the fish, and details of any medications being administered to the fish.

C. Escape Recovery

There are both federal and provincial requirements regarding the recovery of escaped farm salmon. The federal Fisheries (General) Regulations require that a special permit be obtained from DFO prior to attempting to recapture escaped farm salmon. The purpose of this is to ensure that efforts to recapture escaped farm fish do not negatively affect wild

populations. The provincial Aquaculture Regulation requires that an aquaculture licence-holder submit a written report to the Aquaculture Manager within one week of any recapture attempt.

D. Escape Monitoring

Other than reporting escape events, there is no requirement under federal or provincial legislation for an aquaculture licence-holder to monitor a farm’s escaped fish. The only monitoring initiative relating to escapes is the Atlantic Salmon Watch (ASW). The ASW was established in 1991 and is jointly managed by MAFF and DFO. Its purpose is to monitor commercial and sport catches and observations of Atlantic salmon to help determine abundance and distribution of Atlantic salmon in the wild.

E. Salmon Farm Siting

MELP’s Aquaculture Policy outlines a series of salmon farm siting guidelines designed to reduce conflicts with coastal resources and coastal resource users. This includes a guideline for a 1 km buffer between salmon farms and the mouths of salmonid-bearing streams (refer to Chapter 4 for further details). This avoidance is designed to reduce the potential negative effects of escaped farm salmon on wild stocks.

II. Assessment of Existing Measures to Prevent and Mitigate Potential Negative Effects Resulting from Escape Events

Although there are federal and provincial measures designed to prevent escapes and to address the potential negative effects resulting from the escapes that do occur, concerns persist. These concerns are particularly focused on the potential negative effects on native salmonids (Pacific salmon, steelhead, cutthroat trout, etc.) and their spawning and rearing areas. Concerns about the potential effects of escaped farm salmon can be divided into three groups: those related specifically to farmed Atlantic salmon; those related exclusively to farmed Pacific salmon species; and, those related to all farmed salmon species (see Table 14).

Table 14. Concerns Related to Escaped Farm Salmon

Concerns with farming Atlantic salmon <i>Genetic Impacts</i>	Concerns with farming native Pacific species <i>Genetic Impacts</i>	Concerns with farming any salmon species <i>Ecological Impacts</i>
<ul style="list-style-type: none"> • hybridization—resulting from breeding between farm Atlantic salmon and wild Pacific salmon or trout 	<ul style="list-style-type: none"> • interbreeding—between wild and farm Pacific salmon, resulting in dilution or alteration of the gene pool that leaves the wild 	<ul style="list-style-type: none"> • predation—on wild salmon by escaped farm salmon • competition—for resources between escaped and wild salmon

Ecological Impacts

- colonization—of Atlantic salmon in B.C. coastal waters and associated impacts on wild populations

stock less competitive

- disease transmission—from farmed to wild salmon (refer to Chapter 6)

A. Ecological Impacts

The salmon farming industry in B.C. gradually shifted from farming Pacific salmon species (chinook and coho) almost exclusively to farming predominantly Atlantic salmon. This shift towards Atlantics occurred for economic reasons. Atlantic salmon are found to be better suited to farm conditions, primarily, in that they grow faster and can tolerate higher stocking densities than Pacific species. Thus, they are more profitable to raise. Both the federal and provincial governments have approved of the farming of Atlantic salmon in B.C. by allowing the importation of Atlantic salmon eggs into the province and through the approval of aquaculture development plans, which must name the species being farmed.

The issue of farming Atlantic salmon in B.C.'s coastal waters is of significant concern for many people. Atlantic salmon are an introduced or "exotic" species in B.C. and some people view the introduction of any exotic species as wrong in principle. They point to the unforeseen ecological and economic problems resulting from introductions of other exotic species throughout the world to illustrate the potential for significant negative impacts. The review heard the suggestion that land-based or closed-containment culture was the only acceptable way to reduce risks to wild salmon and to prevent other potential negative externalities from farming Atlantics.

There is a detailed history of intentional human-induced introductions of Atlantic salmon throughout the world. However, with the exception of the Faeroe Isles in the northeastern Atlantic, none of these attempted introductions has ever succeeded in achieving a self-sustaining anadromous population of Atlantic salmon outside of their endemic range. The TAT concluded that in B.C., reproductive colonization by Atlantic salmon is improbable but not impossible. With continuously high levels of escapes, and low numbers of wild stocks, the potential for successful colonization could increase. However, even if Atlantics were to reproductively colonize in particular waterbodies, it would likely be possible to target that particular stock for eradication, if that action was considered appropriate.

Even if Atlantic salmon never successfully colonize in B.C., there are concerns that the mere presence of escaped farm salmon in the ocean and fresh water environments will result in significant impacts to native Pacific stocks. People have asserted that escaped farm salmon will represent serious competition to wild salmon for food and other resources. As well, predation on wild stocks by salmon escaping from farms has been raised as a concern. The conclusions of the TAT, however, found that, in terms of both predation and competition,

current levels of escaped farm salmon offer no significant threat to wild stocks. At higher levels of escapes, there may be some localized increases in competition in the immediate vicinity of farm sites. These effects, however, would likely be temporary, and would decline as the escaped fish dispersed over a broader area.

B. Genetic Impacts

Public concerns about potential genetic impacts of escaped farm salmon on native Pacific stocks through hybridization and interbreeding have also been raised. The TAT found the potential for hybridization between escaped Atlantic salmon and wild Pacific salmonid species to be extremely low. However, the risk of genetic damage due to interbreeding between escaped Pacific salmon and wild stocks is potentially high if consistently large numbers of escapes occur and successful interbreeding occurs over several years. This risk, however, must be viewed within the context of past enhancement efforts where many millions of salmon of different genetic backgrounds were intentionally mixed, with little regard to the potential long-term risks from interbreeding.

The SAR also heard serious concerns regarding the potential commercial farming of transgenic salmon. A transgenic salmon has had its genetic composition altered, usually through the injection of DNA from other salmon, other species, or combinations of the two. The purpose of transgenic research is to try and produce favourable altered characteristics in the transgenic fish (e.g., increased growth rate, or improved disease resistance). It is not known whether these favourable attributes could allow escaped transgenic salmon to successfully out-compete wild populations for resources.

Because of the uncertainty regarding how these genetically altered fish would behave in the wild, the current DFO policy is to maintain both physical and biological (reproductive) containment of transgenic organisms. There has been ongoing research into the development of transgenic salmon in B.C., but this has been done under close supervision in closed-containment, land-based facilities.

Currently, there are no transgenic salmon being farmed commercially in B.C., nor has there been any interest expressed for doing so. This is primarily related to the negative public perception of transgenics, and the potential for this to affect all farmed salmon sales. In view of the uncertain potential risks, and the serious public concern that has been expressed, it is recommended that the farming of transgenics continue to be prohibited in marine net-cage systems.

Overall, at current levels of escapes, the risk of adverse effects from escaped farm salmon on wild stocks appears to be low. A great deal of public concern has been expressed with regard to the potential adverse effects of farming Atlantic salmon, an exotic species. The TAT concluded that the potential for adverse effects is associated more with farmed Pacific species

than with Atlantics. The risk is considered higher where a farm raising a Pacific species is located near a body of water with an important or vulnerable native stock. In these situations, there is an increased likelihood that due to proximity alone, escaped Pacifics might enter the stream and interbreed or exclude wild salmon from feed or habitat. For this reason, it is important to avoid locating farms raising Pacific species near sensitive wild streams. In these circumstances, it may mean siting farms beyond the 1 km siting guideline (see Chapter 4).

The conclusion of the SAR is that there is no demonstrable basis at this time for discontinuing the culture of Atlantic salmon in B.C. Arguments to do so are based primarily on “principled viewpoints,” given the experiences of other species introductions in the world where the introduced species was able to competitively exploit an ecological niche. This probability does not appear likely in B.C. given that native salmonids already occupy that niche, and also given the evidence that prior intentional Atlantic introductions here and elsewhere have failed.

Moreover, the economic impacts on the current B.C. salmon aquaculture industry of a policy decision to ban Atlantic culture in the marine environment would be considerable, potentially rendering the industry uncompetitive. Since land-based technology for rearing Atlantic salmon to full grow-out is not yet considered economic (see Chapter 11), farmers would be induced to farm Pacifics, where the ecological risks of escapes are of greater concern.

As discussed above, the TAT concluded that overall, the risk of adverse effects to the province from current levels of escaped salmon is low. However, the TAT also pointed out that continued or higher levels of escapes would increase the risk of impacts in some locations. Moreover, there is a certain level of uncertainty regarding both the potential and the significance of adverse effects. Thus, maintaining vigilance over the potential effects of escaped farm salmon is justified by the need to reduce risk in the face of this uncertainty.

Although the overall numbers of escapes have decreased over time, existing measures to prevent escapes have clearly not been adequate. The existing requirement of the aquaculture licence to take “reasonable precautions” to prevent escapes is difficult to enforce, and to date there has been limited follow-up or verification of escape events by government agencies. In practice, the requirement to report escape events is most often only complied with for what farmers consider to be economically significant losses. The management system for addressing escapes has little or no enforcement, and no incentives/disincentives to prevent escapes other than the economic incentive for farmers to avoid the loss of stock. In total, there have been over one million reported farm salmon escapes into the wild from B.C. farms. The economic self-interest of salmon farm operators and existing management regulations and policies regarding escapes are not sufficiently effective in addressing this issue.

There was general agreement among all participants in the SAR that the prevention of escapes is a worthwhile goal. All of the concerns described previously in this section relate to the potential effects of farm salmon in the wild after they have escaped. Escape prevention should be the main regulatory thrust. Ultimately, the goal of management agencies should be zero escapes.

An effective mechanism to achieve this is by including escape prevention measures in the farm’s management plan and establishing a threshold escape number that, when exceeded, triggers a review of the management plan and requires that any remedial measures identified by the review be implemented. The threshold number should be set as a percentage of the total number of fish stocked into the farm. Recognizing that the ultimate goal is zero escapes, it is suggested that the threshold should be initially set at 3 per cent of total fish stocked and move to zero as quickly as possible, but no later than five years. This threshold number should be treated as a starting point and should be regularly reviewed by managing agencies and reduced as technological and managerial improvements are made.

Implementing these measures will ensure that farmers act proactively by including escape prevention measures in the farm development plan. It will also allow regulatory agencies to provide advice on which technologies and husbandry practices are most effective for ensuring escape prevention. It will also provide a tool to help ensure that these same technologies and husbandry practices are implemented.

The effectiveness of the recommendation outlined above is dependent upon an accurate and up-to-date inventory system. Improvements in escape prevention are dependent upon knowing where and why losses are occurring. In order to determine if threshold numbers of escapes have been reached, both farmers and government auditors need to have an effective means of determining how many fish are being lost due to chronic leakage and/or escape events. To be accurate, the tracking system also needs to be able to separate losses due to disease and predation. Thus, this type of inventory would also be a crucial tool for ensuring the effectiveness of recommendations regarding fish health, and interactions with aquatic mammals (refer to Chapters 6 and 8 for more detailed information).

A computerized inventory tracking system has been developed and is in use on a number of commercial salmon farms in B.C. This system can track salmon stock from the hatchery through to processing and identify and separate key information, including: losses due to predation (various types), losses to disease (various types), losses to escape events, and unexplained losses (chronic leakage). This system should be used as a model for implementation throughout the entire industry. This will require up-front investment from farm owners for implementation. In order to ensure effectiveness and consistency, government also has a role to play in further developing the appropriate inventory system protocols. Establishing a standardized, computer-based system to be used industry-wide would ensure consistency and make review and auditing easier and more effective.

It should be recognized that even with this inventory system in place, there will remain a certain number of fish that go unaccounted. However, this does not diminish the need for this type of tracking system, it simply points to the need for further refinement over time as the body of information is developed. The accuracy of the information recorded is crucial to its effectiveness, as is the ability to determine if threshold numbers have been reached and to identify operating procedural or technological problems. In order to ensure this accuracy, farm operators found to be misreporting information should be penalized through fines.

Reports based on the information found in the inventory tracking system should be submitted on a regular basis. Tying this to the farm's production cycle would likely be appropriate. The inventory system itself should also be open to government inspection and audit at any time. In order to address the principle of transparency, access to data from the inventory tracking system reports should be made available to the interested public and presented in a way that addresses the proprietary nature of some of the information.

The above recommendations will reduce the potential for farmed salmon to enter the open marine environment, thus preventing adverse effects. However, the possibility of escapes, either through individual escape ‘events’ or through ongoing ‘leakage’ cannot be ruled out. The potential for farmed salmon escapes will always exist so long as fish are being reared in an aquatic environment. This suggests that contingency measures are needed to mitigate risks associated with inevitable farmed salmon escapes, even though they should become limited in number. The SAR considered a range of measures, including:

- requirement for salmon farmers to recapture escaped fish,
- requirement for salmon farmers to rear non-reproductive or all-female Atlantic stock only,
- requirement for salmon farmers to develop certain broodstock programs that minimize risks of genetic dilution of wild Pacific salmon,
- increases in the level of active monitoring of escapes, including physically or genetically marking Pacific salmon to enable assessments of the extent of any genetic introgression, and
- research into salmon imprinting using artificial chemical cues that, if implemented, would cause escaped salmon to be attracted to specific locations for easier recovery.

Since the proposed strategy is to place priority emphasis on escape prevention as the principal basis for reducing environmental risks of escaped farm salmon, and because the TAT concluded that the risks associated with escapes are relatively low in the first place, and given the cost implications of developing and implementing various risk mitigation strategies, the appropriate approach is to focus on remedial action to address significant escape events. Salmon farmers should be required to develop escape recovery plans which would be invoked when escapes exceed a specified numerical level. The specified number should be developed

by government, in consultation with industry, taking into account feasibility and logistical considerations.

The successful development and implementation of escape recovery plans is dependent upon the cooperation and support of the DFO. Due to their mandate under the Fisheries Act to regulate Canada's fisheries, any attempts at escaped fish recovery would require their approval. Recognizing this mandate, salmon farmers and the provincial government need to work cooperatively with DFO to develop a process whereby conditional permits for attempts at escape recovery would be issued by DFO. These conditional permits would allow farmers to implement their escape recovery plan when the appropriate conditions are triggered without reapplying for DFO approval.

The effective recovery of escaped salmon will also require an ability to react quickly and efficiently. This will be compromised if salmon farmers are forced to spend time trying to locate a boat and crew that are willing and capable of escape recovery and are available with relatively no notice. In order to address this issue, this report recommends that a regional approach is used. In this respect, salmon farmers and government would develop regional "recovery teams" that would be established and available on-call under any circumstances for all of the salmon farms in a designated region. As discussed in Chapter 9, local people, especially First Nations, could provide a valuable resource to these teams. Again, since DFO, as the lead agency in fisheries management, will be required to issue catch licences to authorize these recovery teams, the participation by DFO in the development of these regional strategies will be crucial.

To facilitate the development of effective escape recovery plans, government should document appropriate escape prevention technologies and procedures as a reference guide for use by farmers when preparing their individual escape recovery plans. The escape recovery plans, linked to the numerical escape standard, should constitute part of the salmon aquaculture licence, thus ensuring their enforceability.

In addition to the requirement for an escape threshold standard and recovery plans, an appropriate and cost-effective measure for mitigating risks associated with escaped salmon is to maintain a minimum level of monitoring. To this end, the Atlantic Salmon Watch program should be maintained, with a focus on specific streams known to have Atlantic salmon and a determination of whether the fish can successfully spawn. This will provide information that enables agencies to adjust management requirements respecting escape prevention and mitigation measures.

C. Further Risk Reduction

The recommended management for escapes, as outlined above, will significantly reduce, but not eliminate, the risks associated with escapes. The remaining risk will not be enough to

require the implementation of severe post-escape mitigation measures. However, the uncertainty that remains justifies the need for focused research, subject to a determination of research priorities, that looks

at means to further reduce risks associated with escaped farm salmon. Specifically, the following research should be further pursued:

- *development of a domesticated farm stock that, even if escaped, poses a minimal genetic risk to wild salmon, and*
- *development of all-female or non-reproductive Atlantic salmon (results after one year of further research should be used to determine whether farming only all-female or non-reproductive Atlantic salmon should be a requirement and to estimate the time frame to implement).*

These risk mitigation measures should be adopted, pending determination of their cost effectiveness through research initiatives (refer to Chapter 10 for further discussion).

In addition to actively engaging in its own research and monitoring efforts, government should commit to maintaining an ongoing review of other relevant research being conducted both in B.C. and other jurisdictions. Of specific interest should be research that investigates the behaviour and ecology of escaped farm salmon in the wild and, more particularly, their potential for successful spawning and impacts on other fish species. Two extensive research proposals are expected to proceed over the next year.² Also the Directorate for Nature Management in Norway is developing a research program based on tagging a percentage of farmed fish. It is expected that this program will be operational in two to three years and should be monitored for its potential usefulness and application in B.C.

Managing agencies generally are aware of ongoing research, but specific agency personnel should be designated to review new relevant research and regularly report on how the results of this research may be used to improve the management of salmon farming in B.C.

CHAPTER 6. FARM AND WILD FISH HEALTH

I. Existing Measures Used to Manage Fish Health

The following sections describe the mechanisms that are currently in effect in B.C. for managing fish health issues in relation to salmon aquaculture.¹

A. Transfer of Live Fish and Importation of Fertilized Fish Eggs and Milt

Salmon farming operations frequently need to transport live fish within the province. For example, smolts must be transferred from the hatchery or lake-rearing facilities to marine grow-out sites. Farmers may also import fertilized fish eggs, and under certain conditions milt, from outside the province to assist in developing broodstocks or for research purposes. Concerns respecting fish health and the movement of live fish, fertilized eggs or milt relate to the possibility of transferring or importing an “exotic” disease or disease-causing agent. New disease agents have the potential, although with a low level of risk, of causing significant adverse effects on the health of wild fish stocks and other indigenous marine species due to a lack of a previous exposure and resistance to the new agents.

The Federal-Provincial Fish Transplant Committee, operating under a MOU between the DFO, MELP and MAFF, is authorized to consider requests for transferring live salmon within, or importing fertilized salmon eggs or milt into, B.C. The committee makes recommendations to fisheries management agencies of both governments on granting import and transfer permits and licences. Their recommendations must consider minimizing the risk of potential disease effects on fish that can result from the import or transfer event. Recent revisions to the risk assessment guide and requirements used by the committee to adjudicate the applications have looked at bringing them in line with the revisions to the federal Fish Health Protection Regulations (see below) and on par with the International Council for the Exploration of the Seas (ICES) code of practice respecting fish introductions and transfers. Such requirements as advocated by ICES may include a more comprehensive assessment of the risks by consideration of the necessity of the importation, the anticipated adverse effects and efforts on the part of the proponent of preventing adverse effects. This information may be considered by the Fish Transplant Committee, but it is currently not mandated that the information be included in all applications.

B. Transfer of Live Fish

For non-tidal waters, the transfer of fish within the province is regulated by the Freshwater Fish Regulation under the provincial Wildlife Act, whereby the transport of fish, including eggs and juvenile stages, requires authorization under a permit. The management agencies consider the recommendations of the Fish Transplant Committee before granting a permit.

At the federal level under the Fishery (General) Regulations, transferring live fish to any fish-rearing facility must be authorized under licence, which can only be issued if:

- *the transfer is in keeping with the proper management and control of fisheries,*
- *the fish do not have any disease or disease agent which may be harmful to the protection and conservation of fish, and*
- *the transfer will not have an adverse effect on the stock size of fish or the genetic characteristics of fish or fish stocks.*

Again, the management agency considers the recommendations of the Fish Transplant Committee before granting a licence.

C. Importation of Fertilized Fish Eggs and Milt

The federal government is responsible for enforcing importation requirements under the Fish Health Protection Regulations, which address concerns about possible disease transfer related to both the importation of live fish, fertilized eggs and gametes into the country and movement across provincial boundaries. Under the regulations, the importation of cultured fish or eggs of wild fish must be done under permit, which also requires that the originating facility obtain a certificate through fish health officers. Certification is based upon repeat testing for specified pathogens. Four consecutive inspections must prove negative, not less than 18 months before the transfer event. The facility must then be inspected approximately every six months to maintain certification.

The importation of live cultured fish requires certification that the fish come from a source that was inspected and found to be free of any disease or disease agent that is specifically listed in the Regulations, and that no fish, other than those that have satisfied the first condition, can have been introduced to the source of the importation within two years immediately preceding the date of the certification. The importation of eggs requires certification that the eggs were taken from wild fish that were inspected and also found to be free of any disease or disease agent that is specifically listed in the Regulations. It is permissible for a certificate to be provided for the transfer if certain diseases or disease agents are detected during the inspection (these are also specifically listed in the Regulations), provided that the officer is satisfied that they will not be harmful to the protection or conservation of fish in the province.

Amendments to the Fish Health Protection Regulations are planned which will allow local fish health officers to approve transfers of eggs and fish between sites, even when disease agents of concern are detected at the source and receiving facilities, and to approve the transfer of disinfected eggs from source facilities or wild broodstocks that have only been tested for viruses. This regulatory approach of more flexibility is generally inconsistent with many of the recommendations of this report. Other significant proposed changes include: expanding the Regulations to apply to all finfish species (not just salmonids as is currently the case), requiring mandatory reporting of listed diseases when the disease is new to a province,

providing the authority to quarantine facilities to prevent the spread of fish diseases that are new to a province, and providing the authority to prohibit the import of live fish and eggs from areas reporting new diseases unknown in Canada. Changes are also proposed to be made to the specific diseases that are listed in the Regulation schedules. However, provincial fish health policies which may be more stringent will take precedent over these changes.

Current policy regarding the importation of fish into the province is stronger than provided for under the federal Fish Health Protection Regulations. In order to help protect indigenous B.C. fishes from the possible importation of disease agents and parasites, the policy of DFO is that all authorizations for importations of Atlantic salmon must be done in consultation with MELP and MAFF. The protocol which must be followed is outlined in the current DFO policy. MELP has not agreed to this policy due to a concern that an explicit maximum number of eggs allowable for importation is not specified. Only surface-disinfected, fertilized eggs are allowed for importation, but there is no number cap. Live Atlantic salmon or unfertilized eggs are not to be imported under any circumstances. Milt may be imported if the broodstock fish from which it was collected complies with the federal Fish Health Protection Regulations. Further, all of the donor males must be sampled for viral disease agents of concern and the eggs fertilized with the imported milt held under quarantine. Fertilized eggs are allowed to be imported only if the parent broodstock has been captive for at least one full generation and the eyed eggs arrive in B.C. a specified minimum time before they hatch.

There are restrictions on the facilities from which the imports come. Facilities must: be inspected and approved by a Local Fish Health Officer, undergo regular monitoring and provide specific documentation, use fish-free groundwater supply and isolation areas for egg incubation if a freshwater facility, and provide access to complete facility records and stock from which the import originated if requested. Importations are not allowed from facilities or sites: where salmon pathogens exist which are not known to occur in B.C., where a designated problematic strain of a fish pathogen exists, and which do not take measures to prevent the movement, control and eradication of fish diseases of concern in B.C.

The policy further stipulates that all imports be held under quarantine in an approved facility. DFO enters into contract with the company operating the quarantine facility regarding the design, operation and monitoring of the facility. Sampling protocol and a monitoring regime are specified. If a disease of concern to DFO is detected during the quarantine period, all stocks must be destroyed and the facility disinfected. The policy specifies times within which all mortality records and test results of the quarantined stocks must be submitted to DFO. Requests by industry for permission to import salmon eggs must be addressed to the Federal-Provincial Fish Transplant Committee.

A policy is also in place regarding the importation of Pacific salmon into B.C., co-agreed upon by DFO and MELP. It specifies that only surface-disinfected fertilized eggs will be imported, and that no live fish, unfertilized eggs or milt be allowed. The importation of eggs

must be from broodstock that have resided in Canadian waters or waters of the continental U.S. for one full generation, and from sites inspected and approved by a Local Fish Health Officer. Quarantine may be required. Importation of Pacific salmon eggs is permitted only for research and broodstock development purposes, to a maximum of 20,000 eggs per licence per year. Exceptions may be made to overcome unexpected domestic egg supply shortages and for scientific research and development purposes (unfertilized eggs or milt may be allowed for the latter).

II. Disease Control and Reporting

MAFF has the mandate to monitor diseases which may be a health concern for farm stock, including fish at aquaculture facilities, and to provide information on diseases of potential concern for either humans or animals to other provincial and federal agencies. The ministry meets its obligations through the Fish Health Extension Program. A provincial Fish Health Veterinarian provides services to farmers, with an emphasis on assessing the importance of disease and management challenges, and designing prevention and control programs. The veterinarian is responsible for identifying those diseases of importance to the viability of the industry, and the health and welfare of animals and the public.

The provincial Animal Diseases Control Act is the provincial legislative authority for the control of diseases on farms. It contains measures that can be used to deal with fish that are, or appear to be, diseased. However, currently none of the diseases listed under the Act are specific to aquatic animals; thus, this legislative tool remains inapplicable to the management of fish diseases. The TAT reported that a disease is usually made provincially reportable if: there is sufficient concern regarding the disease impact, the disease or its agents can be readily identified, and effective measures of control are available. There is concern that due to the indigenous nature of all diseases known to fish farms in B.C., the “wild” sources of the disease agents cannot be effectively controlled, thus complicating control on the farm.

If diseases related to salmon farming were to be listed, and if a fish farm had a listed disease, the farmer would be required to notify the nearest inspector of MAFF. The farmer would then have to take precautions to prevent the spread of the disease and isolate the infected fish, without disposing of the fish. Inspectors may also enter premises and inspect or test fish for the specific diseases listed in the Act or regulations. Diseased fish may be seized, quarantined or destroyed by an inspector, who may also order disinfection of the facility. The Animal Disease Control Regulation requires that a veterinarian report every case of a listed disease to the veterinary laboratory of MAFF. The legislation empowers MAFF to inquire into an alleged outbreak of disease. It also provides for cost recovery mechanisms for many steps taken by the province to control animal disease.

The federal government's role in the management of diseases in fish relates to the protection and conservation of wild stocks. Diagnostic support is provided for the federal salmon enhancement program and for addressing health issues in wild stocks. The federal Health of Animals Act deals with the control of diseases and toxic substances in animals, not excluding fish. A disease which is reportable must be reported to an appointed veterinary inspector. However, similar to the provincial Animal Diseases Control Act, none of the reportable diseases as defined in the Reportable Diseases Regulations are specific to aquatic animals. The Act is currently not being applied to cultured fish.

The aquaculture operating licence, issued by MAFF under the provincial Fisheries Act, requires that a farmer undertake reasonable practices necessary for disease control. The provincial Fish Health Veterinarian is often involved in routine inspections of farms for compliance to the licence. Farm health records and disease control practices and procedures are reviewed. However, as neither the provincial nor federal legislation includes aquatic diseases as reportable, there is no statutory authority requiring salmon farmers to report fish diseases. For cases of disease routinely handled by a farm's attending veterinarian and diagnoses conducted by private laboratories, the provincial and federal government may not be aware of the incident. The provincial Fish Health Veterinarian has initiated investigations in the past due to public inquiries or upon invitation from the farmer, the farmer's veterinarian or enforcement officials. The provincial veterinarian is not consulted on all incidents or for all production problems. The province is not able to provide a comprehensive range of services to the industry or practicing veterinarians. Any assessment of the health status of farmed fish can only be interpreted from the sample of voluntary submissions received, services offered to farms upon request or investigations initiated. The federal government holds information on diagnoses from salmon enhancement facilities and wild fish, but this does not extend to farmed salmon.

MAFF currently does not have an accessible or searchable database which contains the information related to diagnoses or services performed for fish farmers. In response to the B.C. Salmon Action Plan, a disease monitoring and reporting program for salmon aquaculture was initiated in 1995 by MAFF in cooperation with MELP and industry. Differences between MAFF and MELP prevented the program from being implemented. Industry withdrew its support due to concerns over the treatment of confidential information.

A 1995 MOU, co-signed by the DFO and MELP, outlines the responsibility for creating and maintaining a fish disease database, as well as the use and release of information. This information, however, is primarily concerned with the diagnostic work carried out by those agencies as it relates to enhancement facilities and wild fishes.

III. Use of Pesticides and Disinfectants

The use of pesticides on farms potentially includes the use of products to control net fouling and products which are externally administered to control external salmon parasites, such as sea lice. Products to control parasites that are administered through feed (e.g., ivermectin) or injection are controlled as drugs, not as pesticides (see discussion below). The federal Pest Control Products Act outlines the requirements for the registration, sale and importation of control products. The provincial Pesticide Control Act prohibits anyone from applying a pesticide unless a permit is obtained. The permit outlines the terms under which the pesticide may be used and is administered by MELP.

A permit for the application of a pesticide on a salmon farm in B.C. has never been granted.

IV. Use of Drugs on Farms

In order to control bacterial disease in farmed fish, drugs may be administered through feed. They are permitted to be included in the feed used for fish destined for human consumption through standards as provided by the federal Feeds Act. The Feeds Regulations outline: the drugs that can be included in fish feed, the maximum level of drug permitted, and directions and cautions for use.

The provincial Pharmacists, Pharmacy Operations and Drug Scheduling Act also addresses the use of medicated feeds. The Veterinary Drug and Medicated Feed Regulation under the Act lists the drugs which can be used.

Currently, Health Canada regulates therapeutic drugs (including antibiotics, anesthetics and hormones) that can be used in aquaculture through a MOU between the provincial and federal governments. Which drugs can be sold, for what conditions, for what species, and how they are to be prepared for sale are outlined and provided for in the federal Food and Drug Act. Under the Act, provision is made for the appointment of inspectors who have broad powers and whose actions may include entering premises and the seizing of items or records. The Food and Drug Regulations specify requirements for registration and use. There are detailed labelling requirements, including: withdrawal time, restrictions for use, storage instructions, the species to be treated, the specific diseases the drug is effective against for each species, dosage and feeding directions, mixing directions, and any notable cautions or warnings.

There are currently three antimicrobial drugs licensed for use on salmon: Terramycin Aqua [oxytetracycline], Romet [sulfadimethoxine and ormetoprim], and Tribriksen [trimethoprim and sulfadiazine] which are administered in feed. Oxytetracycline can be used without a

veterinary prescription, but use must adhere to specifications on the label. As a matter of practice in B.C. in 1995, all oxytetracycline medicated feed used was under veterinarian prescription. Veterinarians must prescribe the use of the other two drugs, and if in their professional opinion it is warranted, use can deviate from the instructions on the label of any of the drugs. Where a drug is not available for the specific species and condition that are being treated, or if it is believed that drugs currently available for that species and condition would not be effective, a veterinarian has the option of prescribing a licensed drug not specified for use on salmon or for the infection of concern. However, in such a case, certain requirements must be met, including determining the appropriate withdrawal time before the fish can be slaughtered or used for human consumption.

The provincial Pharmacists, Pharmacy Operations and Drug Scheduling Act prohibits the sale of veterinary drugs or the manufacture and sale of medicated feeds except by a pharmacist, registered veterinarian or holder of a licence. Licence holders are regulated under the Veterinary Drug and Medicated Feed Regulation, which also specifies: conditions of sale and drugs which can be sold, requirements for storage and dispensing of drugs, recording purchases and sales, and reporting to provincial government agencies.

The use of hormones is also regulated under the federal Food and Drug Act. Currently a form of testosterone is being used only on broodstock in the B.C. salmon farming industry under controlled conditions. Fish destined for human consumption are not treated with hormones.

Through the provincial Aquaculture Regulations salmon farmers are required to keep records of drugs administered to their stock. The information is to include: the farm licence number and holder, the location of the farm, the species being cultured, the name of the prescribing veterinarian, the drugs used, the procedure for administering, treatment schedule, date of first treatment, date of last treatment, and the name of the person responsible for administering the treatment. The Regulations also require fish farms to deliver, with the stock that goes to a processing plant: a statement outlining the date of last drug treatment (if any), name of the drug, treatment schedule, dates treatments started and finished, name of prescribing veterinarian, and name of the person responsible for administering the treatment. The Regulations further specify that a drug-free period of 105 days must pass before the fish can be harvested, unless standards as provided for the drug in the federal Food and Drug Act or its Regulations are followed, or if a veterinarian has prescribed a mandatory withdrawal period.

V. Drug Residues in Fish for Human Consumption

The federal government is responsible for monitoring aquaculture products destined for human consumption. Under a MOU between the provincial and federal governments, farmed

salmon ready for market are subject to testing by federal inspectors for antibiotic residues, toxic materials and other additives and contaminants.

When fish are destined for export either out of country or out of province, the federal Fish Inspection Act aims to ensure that strict national quality standards are adhered to. Federal inspectors have the power to enter premises and inspect products, and the export or possession of tainted, decomposed or unwholesome fish is prohibited. The federal Fish Inspection Regulations outline the requirements for inspections of fish products at plants and require that quality management programs be in place at facilities. Inspection records in accordance with the management program must be kept for review. Facilities are periodically audited for compliance.

DFO randomly tested samples of farmed salmon for the presence of antibiotic compounds approved for use on salmon. Testing has been done for pesticide and heavy metal residues, although not necessarily for other drugs not approved for use on salmon but which a veterinarian could prescribe. Special investigations for residues have been conducted by Health Canada and DFO for drugs not covered by the regular monitoring by DFO. The newly created Canadian Food Inspection Agency is now responsible for testing for the presence of residues. Currently, the regularity of drug residue testing is dependent on the performance rating of the facility. DFO tested approximately 200 samples per year, from 1991 through to 1996; and of those, 11 samples tested positive for residues of oxytetracycline (concentrations equal to or greater than 0.1ug/g), while there were no positive samples for sulfadimethoxine or sulfadiazine. Results of individual tests are considered confidential. If unacceptable drug residue levels were found, efforts would be made to halt the sale of the product.

The Fish Inspection Act also prohibits anyone from selling fish which are intended for human consumption that is tainted, decomposed or unwholesome. Inspectors (inspectors under the Fish Inspection Act or fishery officers) can enter premises, boats or vehicles and take samples of fish. Inspectors have the power to seize all fish if it is believed that there is reasonable evidence that an offence under the Act or its Regulations has occurred. If there is conviction of an offence, seized fish and containers are forfeited.

The provincial Minister under the Fisheries Act could further require a processing plant or fish buying station to report on any drugs administered to farmed fish delivered to that facility.

VI. Assessment of Existing Measures to Manage Fish Health

It is imperative for the successful management of fish health issues relating to salmon farming that a proactive policy of prevention be adopted. Although a number of existing regulatory measures are aimed at disease prevention, a greater emphasis on the prevention strategy is needed, given the immense importance of the native salmon resource and the substantial uncertainties that remain. A reactive stance towards disease is considered to be high risk, as it potentially leads to: higher rates of disease outbreaks in farmed fish, higher risks to both the industry and the environment (e.g., risks of transfer of disease from farmed to wild fishes and wild to farmed fishes, and risks of human consumption of drug residues from harvested wild species), and greater exposure to negative public sentiment. An atmosphere of provincial and federal cooperation is essential for the continued protection of humans, the wild fish stocks and other life in the marine and freshwater environment.

A. Coordinated and Corporate Decision-Making on Fish Health Issues

It became apparent throughout this review that regulatory agencies do not have a sufficiently clear separation of roles in managing marine and fish health, nor have they accepted the legitimacy of each others' mandate. As identified by the TAT:, comprehensive, complementary and compatible fish disease prevention, control, and surveillance programs must be developed. In order to develop appropriate and efficient programs for disease prevention, all agencies with a management mandate which includes fish health must clearly understand each others' roles and eliminate inconsistencies and redundancies in the services performed.

Agencies must develop a cooperative relationship conducive to information sharing and timely, coherent management. There is a disturbing lack of a cooperative working relationship between the managing government agencies due to differing mandates and conflicting agency priorities. It is unlikely that this situation would improve without institutional changes and the development of common goals and objectives, and integrated management.

A cost-effective approach for promoting inter-agency coordination and cooperation on fish health issues is to establish an inter-agency body a Fish Health Working Committee with a mandate to develop management policies concerning all aspects of fish health, including:

- surveillance,
- field investigations,
- facility inspections,
- fish health assessments, and

- **public reporting.**

To be effective, the committee should comprise individuals with scientific expertise in: fish biology and physiology, fish disease science and pharmacology, and who are representatives from the regulatory agencies with an existing mandate respecting fish health. The proposed committee should operate using consensus decision-making principles, with inter-agency disagreements addressed through an agreed-upon dispute resolution mechanism. The committee should ensure that the operations and decisions are open and transparent, and that they benefit from the advice of other parties with an interest in fish health issues, including: First Nations, MOH, Health Canada, Agriculture and Agri-Food Canada, Environment Canada, industry, and community organizations.

This proposed committee approach to addressing the current problem of a lack of coordination and cooperation in fish health management in B.C. could be implemented without any changes to existing legal mandates of management agencies. The Fish Health Working Committee would, however, need to rationalize its relationship with the existing Federal-Provincial Fish Transplant Committee concerning issues related to the transfer and importation of fish. Elimination of duplication and cost-effectiveness should be paramount.

Consistent with the need for more coherent and coordinated management of fish health issues, is the necessity to address issues consistently for all intensive fish culturing activities in B.C. There should not be different policies and standards for: farmed fishes, private commercial hatcheries, or public and community enhancement hatcheries. All should be managed as components of the larger integrated and interdependent marine and freshwater systems of which they are a part, and should be subject to the policies of the proposed Fish Health Working Committee.

B. Disease Surveillance and Control Measures

An active surveillance program to identify the distribution and frequency of existing disease, pathogens and parasites in commercial, wild and enhanced fish stocks should be a priority. Information is lacking concerning the incidence of disease and disease-causing organisms throughout the waters of B.C. The findings of the TAT emphasize that very little is known of the ecological role of disease in regulating or affecting populations of wild fishes. This information is essential for proactive management of fish health in this province. The TAT concluded that the evidence examined supports the assertion that the current diseases found in fish farms in B.C. are all indigenous to the province. In order to define what diseases should be reportable to managing agencies by fish farmers, to help control the incidences, the diseases in the marine environment that are of concern need to be identified.

Certain stakeholders contend that significant deleterious impacts on the environment due to salmon farming, such as the transfer of disease from farmed fish to wild stock, have occurred. The information base is not sufficient to categorically refute such claims. However, based on a critical review of the available information, the TAT were not able to establish a causal relationship between the activity of salmon farming and the occurrence of diseases in wild stocks. The findings of this review suggest that the risk of this occurring is very low, but nonetheless, there is a lack of clear information on this topic. It is reasonable to conclude that wild and farmed fish are exposed to, and can be infected by the same organisms, and that wild fish can be exposed to pathogens of farm fish origin. Legitimate concern exists that when a severe disease problem is detected, information will not be available to know how to effectively deal with it. This is true for all forms of intensive fish culture and for wild stocks. Currently, there is little knowledge of the potential ecological significance and risk of disease in wild fish.

An active surveillance program alone will not provide all the information to make optimal decisions regarding the management of fish farms and wild stocks as it relates to disease. This is due to the complex nature of the host-pathogen and host-parasite relationships, and the many ecological and environmental factors involved. The active building of an information base is a necessary first step to adaptively managing the fish farming industry.

To make surveillance an effective approach, and to help alleviate the potential financial and resource burden on government, participation by: First Nations, industry, community fishers, and wild fishery organizations, should be encouraged. Training in identification of diseases is essential. Protocols for data collection and sampling need to be established.

The required results of the active surveillance program need to help define the diseases that are to be reported by fish farmers. Until that information is available, all disease events occurring on fish farms should be reportable as a condition of the aquaculture licence. To define a disease event, a threshold level of mortality on farms (not due to other factors such as predation or harmful algal blooms) should be used to trigger the requirement to seek a diagnosis and report to government agencies. The ability of government inspectors to effectively manage a disease outbreak on a farm, if the measures taken by the farmers prove to be inadequate, necessitates inspectors having the power to quarantine, seize and/or dispose of farmed fish based on the triggering of specific and transparent criteria. The costs to government of doing so should be recovered from industry.

C. Enforceable Standards for Fish Health Management on Salmon Farms

As outlined in Chapter 15, there is a priority need to develop a code of practice for the salmon farming industry. This should include: specific disease prevention and management protocols, minimum health record requirements, outbreak management protocols, drug use standards, and disease reporting requirements.

The current management measures under the aquaculture licence require farmers to undertake “reasonable practices” necessary for disease control. This ambiguous provision does not allow for objective performance monitoring and enforcement. The potential for large losses of stock is currently the obvious incentive for a farmer to avoid disease. Documenting appropriate and consistent disease management protocols would, not only ensure that all the farmers are operating to a ‘high disease management’ standard and are doing all that can be done to protect financial investments, but would also help assure First Nations, stakeholders and members of the public that consistent and appropriate control measures are being practised. Industry has actively participated in research to develop vaccines, and this should be encouraged since government resources are scarce. Development of vaccines for all problematic and relevant diseases would be highly beneficial. Compliance with the protocols, as developed under the code of practice and compliance with the Animal Disease Control Act, should become terms and conditions on the aquaculture licence, as a key component of disease prevention.

D. Access to Fish Health Information

The review process was constrained in its assessment of the exact nature of the risks associated with disease issues related to salmon farming due primarily to the lack of adequate baseline information and research worldwide, and an inability to fully evaluate all existing information in B.C. because of proprietary interests. Currently, the policy of both industry

and management agencies is that disease information which relates to a single fish farm or company, or which can be linked to a particular farm or company, is proprietary in nature and thus confidential. The application of this confidentiality filter can significantly reduce the ability to even regionally report information, due to the low number of companies active in fish farming in the province, and each company's high degree of regional concentration.

This interpretation of the proprietary nature of the information has created a public perception of secrecy and "cover-up". It became evident throughout the review that certain members of the public and stakeholders believe that industry is attempting to hide a significant problem, and that management agencies are either actively protecting industry interests or idly sitting by. However, the information which was available to the review indicates that the level of drug use on fish farms is low. For 1995, it was found that 2.1 per cent of all feed used on B.C. farms was medicated. Although certain diseases are definitely a concern for salmon farmers who want to protect their stock, the development of vaccines and improved husbandry practices mean that disease outbreaks and subsequent high levels of medication are not a pervasive concern. When a disease outbreak occurs at a farm, it is nonetheless cause for concern to the farmer and others. The state of individual farms, or practices of individual companies, with respect to disease prevention and management, however, are unknown.

It is essential that a comprehensive fish health database be developed, linking all relevant disease, pathogen and parasite information from industry and management agencies, to assist in restoring public trust and adequately managing the risks associated with this industry. The fish health database should be the primary working tool of government management personnel responsible for fish health issues for all forms of intensive fish culture. It should be accessible and used by the proposed Fish Health Working Committee to inform their work. It is also essential that information on the incidence and distribution of disease, pathogens and parasites be conveyed to the public, as well as distributed among governments and agencies which express an interest in the information. Raw data should be publicly released on a regional or other basis. This should provide governments and interested parties the information they need, as well as protect the proprietary interest of individual salmon farms or individual salmon farm companies. The same approach should be extended to all intensive fish culture operations, including: commercial grow-out sites, commercial hatcheries and broodstock programs, and public and community enhancement hatcheries. Published government reports on the incidence and distribution of disease, pathogens and parasites should also be made available to the public on a regular basis.

E. Stronger Policies and Reporting Requirements Respecting Importations

The requirements of the Fish Health Protection Regulations, in combination with the current policies on the importation of Atlantic and Pacific salmon into B.C., were found to be among the most stringent in the world. The TAT found that the probability of a serious disease outbreak as a result of the importation of an exotic pathogen is low but not zero. The consequences of such an event, however, could be significant, particularly if impacted wild stocks are compromised by other factors. Because of the importance of the wild salmon stocks to the people of B.C., and the conflicting and inconclusive nature of the information regarding the introduction of exotic diseases and their impacts on native fishes in other jurisdictions, improvements in the policies need to be implemented in order to further reduce risk.

The TAT found that current measures governing importations do not apply risk assessment methods that are equivalent to those applied to the importation of terrestrial species in Canada, or of fishes in other jurisdictions. There are some notable deficiencies in the sampling strategies and protocols, such as a lack of consideration for certain factors which could vary the value of the statistics. However, the restrictions on the information available may, in many cases, prevent the application of appropriate risk assessment. This necessitates the establishment of conservative standards and comprehensive protocols until a change in the information base allows for adaptive changes in the management regime.

Not allowing live salmon to be imported into B.C. reduces the concern about the introduction of exotic pathogens into B.C. to those which are on, or within, fertilized eggs or gametes. Further, a policy of allowing only surface-disinfected fertilized eggs into the province, along with the current quarantine and monitoring regime, will reduce the likelihood that a pathogen will be transmitted. However, the procedure is not fool-proof. The disinfectants used are not 100 per cent effective at removing surface pathogens, even under perfect operating conditions. Other pathogens are known to be found within the egg, and thus, are inaccessible

to surface disinfection. To further reduce the risks of importing an exotic pathogen to B.C., restrictions on the total numbers of eggs which are allowed to be imported should be implemented. The restrictions should consider the minimum requirements for industry broodstock development and research.

Particularly lacking from the current regulations and policies concerning importation of fish eggs, is the proactive development of disease control strategies if an exotic pathogen with a potentially significant deleterious impact on indigenous fish stocks is imported. Control strategies must be in place. Such a plan could effectively be developed by the Fish Health Working Committee. The application of the provincial Animal Disease Control Act, through specifying fish diseases in the Regulations, would further strengthen available control strategies.

It must be recognized that industry currently requires imports of eggs from outside the province in order to maintain a healthy broodstock and to develop Atlantic salmon strains which allow the industry to be competitive in the international marketplace. However, it is also true that industry has greatly increased its ability to maintain independent broodstock programs. Requests for egg imports have decreased over the years. It is reasonable to expect that a point can be reached whereby importation of new genetic material is no longer necessary once this capacity is realized. Industry should be encouraged to reduce the required number of egg importations to zero.

F. Improved Requirements for Sampling and Reporting when Transporting Fish

Current requirements for the reporting of diseases at fish farms, which may be of concern due to a transfer of fish within the province, are inadequate. Similarly, information on the presence of disease agents (pathogens and parasites) associated with broodstock or juvenile fish is lacking. The TAT concluded that the current system of approvals is insufficiently standardized and monitored, with a lack of government resources to effectively prevent the movement of disease agents throughout the province. To reduce the risk of transferring a disease agent to either wild or cultured fishes, stronger requirements for sampling and reporting should be implemented.

To efficiently use limited government resources and reduce the reporting burden on industry, requirements for reporting should ideally be based on a quantitative risk assessment that takes into account: the transfer event, information from the disease surveillance program, and the disease agent in question. This is indeed what the current Federal-Provincial Fish Transplant Committee does, and recent efforts to revise the risk assessment guide used to adjudicate applications have made further advances. However, the current low level of scientific knowledge and public trust prohibits a strict quantitative risk assessment from being an appropriate method of operation. The frequency and nature of sampling for monitoring and reporting of the health status of transferred fish should not be open to adjustment based on the specific importation event. It may become possible in the future to adjust specific requirements for each event based on a sufficient reduction in uncertainty as a result of surveillance and increased knowledge.

G. Public Health Safety Measures

The risk of a fish pathogen from salmon produced in B.C. directly impacting the health of a consumer is extremely low. Generally speaking, the pathogens causing sick fish on farms do not infect people. People are affected by pathogens associated either with poor handling and preparation of the fish (e.g., botulism), or the consumption of infected wild fish (e.g., anisakiasis). The diseases found on fish farms are not known to have human health

significance. Most pathogens associated with disease in both fish and humans are widely distributed in the environment.

MOH, in cooperation with Health Canada, has agreed to undertake a preliminary review of the effects on human health associated with salmon farming and to implement appropriate research. The following should be considered prior to implementation of that program. No direct evidence or reports of adverse human health effects due to antibiotic use on fish farms could be found by this review. However, drugs being used as an additive to feed for cultured salmon may be cause for concern. Current levels of use are relatively low, but governments should do more to ensure the cautious and informed use of all drugs, and help promote culturing practices which will lead to a further reduction in use. The previous fish health recommendations will help achieve this, but to ensure that drug residues are below those currently allowed for human consumption, the provincial and federal governments should also enhance practices for inspecting and monitoring the product before it reaches consumers. Sampling at processing facilities should be reviewed and increased from current levels, if found necessary to reduce the risk that any product, which does not meet the current standards, goes undetected. Further, in order to identify trends and indicate potential issues, treatment records with shipments to plants should be regularly reviewed. Results of fish health inspections at processing facilities and drug treatment records with shipments should be integrated into the Fish Health Database for ease of access and to allow integrated analyses with other fish health information.

The primary concern with the use of drugs as additives to fish feed is the lack of certainty regarding whether non-farm fish, shellfish and other marine resources that consume waste feed contain drug residues. The concern for contamination has had a significant effect on First Nations, who avoid harvesting of resources near farms due to the uncertainty. It is not known if any changes in the bacterial community surrounding net-cages affects food-safety risks associated with the harvesting of shellfish. Information on the persistence of drugs and their biological activity in the marine environment is also lacking (also addressed in Chapter 7).

There is concern that treated fish that have escaped might be captured and consumed before the prescribed drug withdrawal period has elapsed. If captured and consumed by humans, an allergic reaction to the antibiotic is possible. Current farming practices do not provide the public notice of when and where other marine animals might be exposed. The public should have access to this information through the use of indicators on farms, to be used at all times that drugs are being used and throughout the prescribed withdrawal period. Similarly, notification of what specific drugs are being applied should be posted and easily visible.

Some participants in the review have also expressed concern that the use of antibiotics will inevitably contribute to the selection of drug resistant strains of bacteria. These, in turn, could possibly hinder treatment of the diseases in other intensive fish culture facilities, or selected strains could transfer resistance to other bacteria for which humans are susceptible and thus hinder treatment of any resulting illnesses. The reality and level of this risk are currently being debated in the scientific literature. As concluded by the TAT, the transference of antimicrobial drug resistance from marine organisms to humans is hypothetically possible, yet not proven. The incremental increase in antimicrobial resistance in human pathogens that would arise from salmon farming would be very small in comparison to alternative sources of resistant organisms. The MOH should undertake a risk assessment of these impacts and determine if further research is needed.

These recommendations are intended to reduce the amount of antibiotics and other drugs which enter the marine environment. To complement the above measures, there is a need to strengthen the control of drugs which are used on salmon farms. This includes requiring that: all drugs used on farms be under veterinarian prescription, use be regularly evaluated by the Fish Health Working Committee for changing patterns to identify arising issues, and information related to drug prescription and use be integrated with other fish health information for analyses. Once these measures are achieved, it is believed that the risk of a deleterious effect on the health of the public will be extremely low.

Concern was expressed during the review about the use of antibiotic drugs on farmed salmon that may also be prescribed for human use. This issue is also of concern where antibiotic drugs are administered to other animals raised for human consumption. Since the use of antibiotic drugs in these circumstances is not limited to farmed salmon, the issue should be addressed in the broader context of reviewing all antibiotic drugs administered to species raised for human consumption which are also prescribed for human use. Since these issues are outside the terms of reference for this review, the provincial and federal Ministers of Health should direct this review with input from appropriate government agencies and all interested parties.

The review also heard concerns raised about the federal approval process for drugs under the Food and Drug Act not giving due consideration to the potential environmental impacts of

those drugs when applied to the farmed salmon. This matter should be considered by Health

CHAPTER 7. WASTE DISCHARGES I

I. Marine Salmon Farm Sites

The main wastes produced by salmon farms are uneaten fish feed and fish faeces. At marine grow-out sites, these wastes are not currently collected and thus disperse to the marine environment. Wastes accumulate under, and in most cases are localized to, within 30 metres of the edge of the net-cage. The degree of accumulation of waste is dependent on a number of factors including: efficiency and effectiveness of fish-feeding regimes, positioning of net-cages on site, bottom topography and currents. Currents can disperse wastes so that under certain circumstances some are suspended and carried away from a site. Because there is no collection system, direct comparisons to point source effluents discharging through a single point should be made cautiously. Net-cages may be moved within a tenure and certain tenures may not be constantly in use, so comparisons to other marine uses that are continuous and stationary may not be appropriate. Accordingly, it is impossible to simplistically compare salmon farming outputs with those of other industries.

Accurate measurements of the impact of salmon farm waste on the environment and management to ensure that the impact does not degrade the environment are needed.

Fish feeds are at times medicated with antibiotics to treat fish disease. A precise record of the treatment regimes at individual farm sites was not made available to the review since information in this form is not made available to government. Annually, however, the registers from all dispensers of medicated feed are supplied to the Provincial Veterinarian showing the date of purchase, source, quantity, and name of the drug. These data enable the Provincial Veterinarian to compile information about use of medicated feeds for livestock generally, and to extract from that, the use in salmon farming. The use of antibiotics varies with the disease management requirements at a salmon farm. Some farms may have to treat fish several times in a year and others may not have to treat fish with antibiotics in a grow-out cycle. In 1995, 2.1 per cent of the fish feed used in B.C. contained antibiotics. Treatment is dependent on the need to manage fish disease. Since salmon are now inoculated against vibriosis, furunculosis, enteric septicaemia and enteric redmouth, antibiotics in feed are generally not used to treat these diseases (see Volume 3).

When used, residual antibiotics not absorbed by the fish can enter the environment in uneaten feed and faeces. Each antibiotic degrades and loses its effectiveness at a unique rate which is different if in the water column or in sediments. Oxytetracycline, one of the more commonly used and persistent antibiotics, loses its effectiveness in the water column after 30 days and in about the same time frame in sediments. However, the drug remains measurable in the sediments for several months but probably in a biologically inert state. Information is lacking regarding whether or not antibiotics are transferred from the sediments to biota, and overall information regarding impacts of antibiotics in marine waters is poor. The ability of

sites to remediate is dependent on the biological activity of the bacteria living in them. This subject is only recently being looked at and

requires more work. Accumulation of antibiotics in marine resources adjacent to farms is a concern, especially to people relying on those resources, who are often First Nations people.

Other wastes from farm activities include human sewage, garbage associated with farming activities (e.g., feed bags, worn out equipment) and antifoulants from nets. If nets are cleaned at the sites, the organisms removed from the nets may also be considered waste. Dead fish and disinfectants used in farming also require disposal.

A. Waste Impacts

Nutrient input from wastes accumulating under net-cages initially enriches the sediments. With further enrichment, if the sediments and biota cannot assimilate the wastes, the sediments move into a state of overloading. If there is no intervention to reduce the wastes, or allow biota and sediments to assimilate them, degrading sediments will result in anoxia, the production of hydrogen sulphide and methane gases. Such conditions are toxic to most organisms.

Sedimentation resulting from wastes can result in the smothering of natural biota. The sediments of many but not all farm sites have been investigated with varying methodologies, so the sediment inventory is not complete and the information is not directly comparable among sites. Known impacts are mainly localized to areas directly affected by the net-cage grow-out.

There are concerns about the accumulation of phytoplankton cysts in the sediments, but no information as to whether they can recycle into the water column. The recommended approach to sediment recovery or remediation is through fallowing.

There is no evidence of impact on water quality from farms on a regional basis. The potential remains for localized impacts to occur under circumstances of poor water dilution and flushing. Observable suspended solids have been noted around a few farms. If the sites are in embayments, deposition on shore occurs in areas of poor flushing. As mentioned earlier, the fate of antibiotics used to treat fish disease in the environment is not understood well.

Currently, one operator is undertaking a four year "holistic" assessment of sites in the study area. The study began in early 1996, and will include assessments related to a complete production cycle and post production remediation. The study includes an assessment of effects of a salmon farm on shellfish with respect to mortality rate, growth, quality and taste. The study will be completed in 2000. The information from this assessment would be extremely beneficial to government and First Nations.

II. Current Management Framework2

The provincial Waste Management Act prohibits the introduction of all waste into the environment from industry, trade or business, unless it is done in a manner consistent with the regulatory

framework. Under the Aquaculture Waste Control Regulation, farms that utilize under 630 dry weight tonnes per year do not require a permit, but must:

- operate in a way that minimizes odour, spills, and impacts on wildlife,
 - comply with a monitoring plan,
 - comply with requests for information,
 - provide notification of changes in operation pertaining to type and amount of waste produced,
 - report pollution and implement a plan to clean up pollution, and
-
- **obtain approval for a plan to deal with and dispose of dead fish.**

Farms do not require a permit for the introduction of treated domestic sewage when it is:

- under 2.5 m³ per day,
 - collected and treated in a septic tank and retained for at least two days,
 - discharged at more than 15 metres depth, and
-
- **located at least 125 metres from commercial or recreational shellfish.**

Permits are required for farms that cannot meet the domestic sewage criteria or the minimum feed usage. The permits generally provide direction with respect to the sewage outfall, set a feed usage limit and direct the permittee to employ good management practices. Solid waste and fish mortalities must be disposed of in accordance with these practices. Feed and chemicals used on the farm must be stored in a way that minimizes odour, spills and impacts on wildlife, also in accordance with the practices. Permits also establish the monitoring requirements for the receiving environment, sampling procedures and reporting requirements (every three months and annually).³ Annual fees for the operations without permits are base fees (currently \$100). Those with permits would pay annual fees of \$800–\$1,100. The rationale for this structure appears to have been that since fish feed and the by-products of the feed constitute most of the waste from salmon farms, those farms using more feed would result in higher effects than those using lower feed amounts. However, with so many other possible influencing factors, such as the bathymetry and hydrodynamics of a site, as well as the husbandry regime, no direct relationship has been established between effects and amount of feed used at a site.

III. Assessment of Existing Measures and Recommendations

The current approach has controlled and minimized impacts associated with nutrient loading in the water column and dealt with issues of disposing of dead fish. The scheme has not consistently prevented localized adverse benthic impacts at all sites. In the absence of good data to provide ongoing adjustments to husbandry practices at the farms, farmers have been managing to a standard of environmental quality necessary to support production of fish in the net-cages, which may not be a standard necessary to protect the surrounding resources.

On the basis of an examination of the sources of waste related to salmon farming, the known and suspected adverse effects associated with these wastes and the current management approach, a new approach is recommended with respect to regulation under the Waste Management Act.

A. Performance Based Standards

The new approach would enable the implementation of performance-based standards for the management of water quality and benthic impacts at all farm sites. All farm sites would be subject to regulation and exempt from the requirement to hold a permit, provided that the operator complies with the regulation. Permits would not be issued. A new fee regime should be developed, corresponding to this approach, but consistent with the user or polluter pay principles of government (as outlined in the Waste Management Permit Fees Regulation). This recommendation is aimed at improving government's approval process with respect to waste management, but also at encouraging better methods to prevent or mitigate adverse effects. MELP is encouraged to develop guidelines for the development and implementation of a new waste management framework based on the following recommendations. Implementation of this approach will meet the longer-term objectives of MELP in shifting most industries to their emerging Pollution Prevention Planning Program.⁴

The effects of salmon farm waste on the environment must be monitored so that adjustments can be made to farm operations to avoid degradation of the sediments. Waste management that avoids degradation is beneficial to the environment and to the farmer, ensuring that outgassing of compounds (methane and hydrogen sulphide) harmful to fish is avoided and the time needed for sediments to return to close to ambient or slightly enriched conditions is shortened. Requiring that sediments recover before restocking will mitigate the overall impact fish farms have on the benthic environment.

Standards for metals in the water column and sediments have been adopted by the province and should be applied to the waters and sediments in and around salmon farms. Water quality sampling should be undertaken when sediments are sampled and trends should be monitored to ensure no cumulative impacts from nutrients in the water column.

B. Approach to Development of Regulation:

1. Setting Standards

The TAT has recommended parameters for measurement of standards that should be tested. They were recommended on the basis that they are easily and reliably measured. Given that this report is recommending that a regulation be developed to apply the standards industry-wide, they should be tested, to ensure consistency with government policy and feasibility, before being codified. Some impact to the benthos (flora and fauna in the sediment) from the discharge of wastes should be allowed under the net-cages, but conditions of degradation should be avoided. Developing standards for allowable impacts will take some time and will be dependent on a good working relationship between industry and government.

Given the variety of sediment types, the standards may have to be set as a range, tied to a classification of sediment based on grain size and type (ratios), or be regionally specific. Alternatively, a measurement of degree of change from ambient may prove to be the useful standard. The parameters recommended by the TAT provide a useful range of criteria to test for establishing the standards.

During this standard testing phase, MELP will have to establish the sampling program and protocols. It is recommended that infaunal diversity and biomass be measured as well as the physical and chemical parameters. Correlations between the biological, physical and chemical data will determine whether or not easily measured physical or chemical parameters can be selected as indicators of biological activity. Establishment and assessment of reference sites will be necessary to provide a measure of “ambient” conditions. Sampling methods should be approved by MELP and include points under net-cages and outward to the edge of the tenure. Sampling and analysis during this test phase should be collected by third-party, independent specialists. Benthic and sediment sampling should be conducted at three times during this stage to give information at the start, peak and end of the grow-out cycle.

If the siting criteria recommended in this report are followed, it is not expected that net-cages would be situated over naturally occurring anaerobic sediments because these sites tend to be stagnant, have poor water quality, and have the potential for significant waste accumulation under the cages. If, despite siting standards recommended in Chapter 4, some existing farm sites are over anaerobic sediments in future, a degree of acceptable change in the characteristics of the benthos would be required as a measure of acceptable impact.

All data should be reported within 30 days of collection in both an electronic and written form established by MELP. MELP may require the third-party consultants to undertake statistical

analysis of data submitted within 30 days of collection and provide a complete report at the end of a grow-out cycle.

2. Optional Scheme

MELP has identified the need for changes to the waste management scheme since 1994, however, if MELP is unable to apply resources to develop standards based on the TAT recommendations, there are some working examples of performance-based standards being applied in other jurisdictions to manage salmon farms. The parameters recommended by the TAT as the basis for standards are similar to those being utilized in performance-based monitoring in New Brunswick. The program in Washington State establishes a size to the zone of allowable impact and somewhat different standards than New Brunswick, but no performance standard within 30 metres of the net-cage. Physical and chemical parameters are measured and under certain circumstances biological surveys are also required. The New Brunswick scheme is closer to that recommended by the TAT. Either of these schemes would require some adjustment to include local specificity. The time and resource savings made in the short term by adopting another jurisdiction's program may be offset by the need for ongoing adjustments, which would be counterproductive for government and industry because these standards will likely not be effective out of the jurisdiction for which they have been developed.

3. Existing Regulatory Scheme to Apply During Development of New Performance Based Regulation

Assuming that the new approval process is followed for the issuance of new tenures, a detailed biophysical assessment will be completed for the site and pre-operational data collected. If the recommended criteria for flow and currents are taken into account, the site conditions will minimize accumulations of waste. Proceeding with new sites under these circumstances will ensure protection of the environment. The operator will be permitted to farm on condition that the operation may have to change during a grow-out cycle to comply with regulated performance standards. New tenures could be issued provided that it was clearly stipulated to the tenure holder that waste management requirements could change within a relatively short period of time.

New farm sites present an opportunity for pre-operational monitoring to provide baseline data. A reference site should also be established.

The current regulatory framework will continue to apply to existing farms until a new regulation is enacted. As an interim measure, the current regulation could be modified to change the requirement that farms utilizing feed of over 630 tonnes/yr require a permit, to a requirement for all farms to adopt a waste management plan approved by the Regional Manager. This would enable a shift to the new regulatory approach.

4. Establish A Registry of Operational Farms and Continue User/Polluter Pay Policy

This approach would provide the public with a source of information about which sites are active, especially if accessible electronically. The proposed approach to cost recovery is consistent with current MELP policy regarding “polluter pay” and other environmental users.

5. Implement Consistent Enforcement and Audit Systems

It is essential that industry play a strong role as stewards of the environmental resource. MELP should monitor and audit results, as well as take steps to ensure compliance, if necessary. The TAT recommendations regarding the use of recognized, qualified third-party consultants to undertake monitoring under the regulation are important. Many consultants and First Nations organizations with qualified staff could provide monitoring and audit services. One measure of success for any regulatory regime is the degree or rate of compliance. Effort and resources must be applied to assess compliance once standards are set and move industry into remediation where there is no compliance. Punitive action (fines/prosecution) should be adopted for failure to implement remedial action plans or for repeat non-compliance.

C. Remediate Existing Degraded Sites

It has been suggested by the TAT that reviews of video recordings of the bottom under certain net-cages indicate that operational adjustments are needed immediately and that some sites may require immediate recovery through fallowing (refer to Recommendation 8 respecting assessment of existing sites).

D. Undertake Research on Impacts to Wild Resources on a Priority Basis

Local impacts regarding siltation on beaches and sediment changes have been noted by people who live in areas near fish farms. First Nations are concerned about the impacts of salmon farms on local wild resources, causing some to avoid resources upon which they have been traditionally reliant. Information is needed to assess whether there are negative impacts associated with excessive siltation and antibiotic use, and if so what mitigation measures can be implemented to avoid these impacts. Recommendations regarding notice of antibiotic use have been made, which will provide local users with information as to when antibiotics are in use.

E. Review Policy Prohibiting Polyculture

On a lower priority basis, the policy enforcing monoculture should be reviewed to determine the possibility for multispecies culture and the related positive and negative effects. It has been suggested that cultivating other species such as shellfish adjacent to salmon farms would remove suspended particles from the water column.

F. Enhance MAFF Computer Model on Basis of Research and Ongoing Monitoring Data

The usefulness of the MAFF computer model in predicting site capability (refer to Chapter 3) would be enhanced by the results of the identified research and monitoring program. As well, the model could have application as an operational tool.

CHAPTER 8. INTERACTIONS WITH COASTAL MAMMALS AND OTHER SPECIES¹

A number of fishes, coastal mammals and birds are attracted to salmon farming operations because they are a potential food source for those animals. Farmed fish are the main attractant, especially for seals, sea lions, river otters and some birds. To a lesser degree, uneaten fish food that settles to the ocean bottom, fouling plants and animals that grow on salmon farming structures, and lighting used on fish farms, attract some birds, fishes and other marine life.

Loss from mammal predation which occurs when wildlife enter salmon farm net-cages and kill or injure salmon stock, is a significant economic concern to salmon farmers. Aside from direct mortality, salmon that have been under attack may receive small wounds that reduce their market value, and stress caused by predator attacks may cause fish to reduce feeding and increase their vulnerability to disease. Tears and holes in net-cages caused by predator attacks can also cause farmed salmon to escape.

About half of all farms in B.C. experience fairly substantial predation losses. A 1989 estimate put salmon losses from predation mortality and escapes due to predator net damage at 1.5 per cent of total industry production in that year—over 200,000 fish. Total predation costs to the B.C. salmon farming industry for 1996 are estimated at as much as \$10 million.

Given these figures, it is understandable that salmon farmers go to considerable lengths to prevent or deter predation losses. A range of methods are employed to this end, including:

- *Predator netting and other physical barriers*—such as; exterior predator nets; top nets, double-bottomed nets; overhead wires/lines to deter birds; maintenance of net rigidity; using rounded and larger nets; reduction of net mesh size; and, installation of perimeter fencing, including electric fencing, primarily to deter river otters,
- *Acoustic deterrent devices*—underwater sound-generating devices that are aversive to marine mammals and are intended to keep or drive marine mammals away from salmon farms,
- *Shooting*—normally seals, which are the most common marine mammal predator,
- *Scaring devices*—such as the use of gunfire, above-water noise makers, scarecrows, lights and dogs,
- *Secure storage*—of fish feed, garbage and morts, primarily to reduce attraction of birds and bears,
- *Trapping*—either to kill or relocate the animals, mainly river otters and minks, and
- *Guarding*—using armed farm staff or guard dogs, normally at night since most predator attacks occur between dusk and dawn.

1. EXISTING MECHANISMS USED TO REGULATE/MANAGE SALMON FARM AND WILDLIFE INTERACTIONS

Predation prevention/deterrence technologies and practices that are employed at salmon farms are currently regulated and managed by government through several means. A summary of these mechanisms is shown in Table 15.

Table 15. Existing Mechanisms Used to Regulate and Manage Salmon Farming— Wildlife Interactions

1. Aquaculture Licence

Issued under authority of Aquaculture Regulation, pursuant to provincial Fisheries Act, administered by Ministry of Agriculture, Fisheries and Food (MAFF)

- general provision contained in aquaculture licence, requiring salmon farmers to prevent predation.
- aquaculture development plan, also a requirement of the aquaculture licence, may incorporate specific predation prevention measures (e.g., net, fencing, secure storage systems).

2. Licence to Kill Marine Mammals

Issued under authority of Marine Mammals Regulation, pursuant to federal Fisheries Act, administered by Department of Fisheries and Oceans (DFO)

- killing of marine mammals prohibited without valid licence, issued by DFO.
- licence gives salmon farmer authority to kill seals and sea lions in situations where conventional predation control methods have been ineffective, and subject to submitting quarterly reports on kills.

3. Permit to Operate Acoustic Deterrent Device (ADD)

Issued under letter of authority from DFO

- gives salmon farmers authority to operate underwater sonic devices that are disagreeable to marine mammals.

4. Licence to Trap or Kill Wildlife Under Provincial Control

Issued under authority of provincial Wildlife Act, administered by Ministry of Environment, Lands and Parks (MELP)

- killing of provincial wildlife (e.g., bears, river otters, birds) prohibited without valid licence, issued by MELP.
- licence provides authority to trap or kill wildlife, subject to conditions imposed in the Act, Regulations and licence.

5. Migratory Bird Convention Act

Administered by Canadian Wildlife Service

- prohibits killing of migratory birds (including waterfowl, gulls and herons) unless the species is “listed” by regulation, and a licence is obtained allowing an individual to kill listed birds.
- no species that interact with salmon farming are listed, thus preventing them from being killed by legal means.

6. Siting Guideline to Separate Salmon Farms from Seal/Sea Lion Haulouts

Policy guideline, administered by MAFF

- unwritten operating guideline is to restrict the issuance of aquaculture licences to farms that are located at least 1 km from known seal and sea lion haulouts as a means of reducing predation problems.

The aquaculture licence issued by the MAFF requires farmers to undertake “reasonable and lawful husbandry practices necessary for preventative predator control.” This is a standard provision in all aquaculture licences. What is “reasonable and lawful” is not defined in the licence; however, licensees must also comply with the provisions contained in their aquaculture development plan which may incorporate specific measures (such as netting, fencing, secure feed storage systems) that must be employed to prevent predation problems.

Marine mammals cannot be killed without a licence issued by DFO under authority of the Marine Mammals Regulation, pursuant to the federal Fisheries Act. Licences are issued where farmers can demonstrate that non-lethal predator control methods were ineffective, and they must submit reports of the kills and try to recover the animal for research purposes. Most operating farms possess valid licences. Shooting must be done in accordance with the provincial Firearm Act which stipulates that anyone using a firearm must exercise care for the safety of other persons or property. As shown in Table 16, over 3,800 harbour seals, California sea lions and Steller sea lions have been reported killed by salmon farmers in the past eight years.

Table 16. Reported Kills of Marine Mammals at British Columbia Salmon Farms, 1989-1996

Year	Harbour Seal Reported	Steller Sea Lion Reported	Number of Active Licences to Kill Marine California Sea Lion	
			Mammals Kills Reported Total	Kills Kills
1989	2	3	0	
0	3			
1990	60	790	6	
5	801			
1991	66	502	7	
5	514			
1992	65	431	7	
9	447			
1993	64	380	13	
7	400			
1994	71	528	4	
8	540			
1995	79	589	25	
14	628			
1996*	82	475	36	
10	521			
Total			3,698	98
58			3,854	

* Preliminary estimate—1996 data collection and analysis incomplete

Source: DFO, 1997.

ADDs are authorized by DFO. The permit requires the holder to maintain a record of observation at the site of non-targeted marine mammal activity/behaviour and submit that information, together with records of operational use of the devices, to DFO on a monthly basis. In addition, the devices are supposed to only be activated when there are harbour seals or sea lions in the vicinity of the pens, and de-activated once the predators depart the immediate area. Seventeen permits for these devices have been issued by DFO. This accounts for about 20 per cent of all B.C. salmon farms.

Terrestrial mammals such as bears, river otters and mink are protected by the provincial Wildlife Act and may not be killed or trapped without provincial authority under that Act. Killing or trapping of these animals may be done only by a licensed individual. If the intent is to trap and relocate the animals, MELP staff will normally refer the salmon farmer to a licensed trapper.

The Migratory Bird Convention Act, administered by the Canadian Wildlife Service, protects migratory birds in Canada. It provides a number of protective measures for a wide range of birds, including some species that interact with farmed salmon, such as waterfowl, gulls and herons. The Act allows permits to be issued to kill listed species that cause a serious impact on agricultural interests. No birds that interact with salmon farms are listed under the Act, and they may therefore not be killed through any legal means.

In addition, although it is not a regulatory requirement, or even a written policy requirement, MAFF's normal practice, when considering new aquaculture licence applications, is to only approve licences where farms are to be located at least 1 km away from known seal or sea lion haulout sites. The effectiveness of this measure is questionable, however, given that these animals routinely travel considerable distances, certainly beyond 1 km, in their search for food.

II. Assessment of Existing Measures

There are a number of concerns associated with the above-listed tools that are currently in use to regulate/manage salmon farming and wildlife interactions. These are discussed below, and recommendations are provided to address the concerns.

A. Killing of Predators

As shown in Table 16, a significant number of predators are reported killed each year at fish farms in B.C. It was suggested by some participants in the SAR that these figures understate actual predator killing at salmon farms. Killing at these levels would appear to reflect a general ineffectiveness in predator prevention efforts. Animals are being killed because there are not adequate physical barriers to stop predation from occurring in the first place. Physical predator prevention systems such as predator netting and secure feed storage facilities are expensive, and it may be that farmers are deterred from making investments into these measures, given the uncertain business climate, when they have the low-cost option available to them of shooting the predators.

In terms of ecological effects of killing predators at these levels, the TAT was unable to conclude from available information that provincial seal or sea lion populations were being negatively impacted. They did, however, suggest that there may be some negative impacts on local populations, where killing occurs over short time periods at relatively high levels. It should nonetheless be noted that harbour seal and California sea lion populations have increased substantially in B.C. in recent years.

Aside from potential population impacts, there is a significant perceptual problem with killing marine mammals. It is not viewed as an acceptable practice by many segments in society, and there may potentially be issues raised in the marine tourism sector if the practice continues at current levels, or increases. Certainly, First Nations people object to killing marine mammals at these or any levels, mainly on the basis of potential interference with their rights and interests.

Finally, shooting in darkness, because that is when predators usually attack, is a source of concern for public safety, even if the individuals shoot cautiously.

For these reasons, it is suggested that greater efforts at predator prevention to minimize the need to kill predators, and tighter controls on shooting practices, are needed. The salmon aquaculture licence and development plan could provide an effective tool for achieving these purposes. Operators could be required to identify the specific measures that will be applied to prevent and minimize predation problems, and these could be incorporated into the salmon aquaculture licence development plan, which would make them enforceable. MELP has prepared a set of guidelines for preventing predation problems on salmon farms. These could serve as a starting point for the development of a more current and comprehensive set of guidelines for salmon farming proponents to follow in preparing and submitting their “predation prevention plans” for review and approval as part of the aquaculture licensing procedure.

With predator prevention as the focus, possibly coupled with greater emphasis on the trapping and relocation of problem predators, the need to shoot predators should decline significantly. It is accepted, however, that the need to deal occasionally with a persistent predator by killing it will continue. Licensed shooting of predators should still be allowed at salmon farms, but under tighter controls than exist presently. It is recognized that enforcement of these controls is difficult given the remoteness of most salmon farms and the limited availability of enforcement resources.

B. Acoustic Deterrent Devices (ADDs)

Seventeen ADDs have been authorized for use at B.C. salmon farms. The potential impact of these devices on non-target species has raised concern to some. The SAR received

submissions outlining these concerns based mainly on local observations. The results of some scientific research on the subject was made available to the SAR.

Conclusions reached by the SAR scientific advisors respecting impacts of ADDs are that:

- Although ADDs are reportedly effective for up to two years, effectiveness is variable among farm sites, and appears to diminish with time. Pinniped (e.g., seal and sea lion) attacks occur even where ADDs are used. It is thought that effectiveness is related to an animal's prior experience. It is assumed that animals that continue to attack sites with ADDs have experienced past success, and that these animals are sufficiently motivated by previous success and hunger to withstand the intense ADD signals,
- Predator success depends on the predator net system or type of net pen, net rigidity, material and mesh size, and the motivation of the predator, which may be related to the availability of other prey choices,
- The long-term impacts of high intensity signals from ADDs marine mammals are not conclusively known; however, pinnipeds (e.g., seals and sea lions) that are not deterred by the devices may experience hearing damage at close range. It is not known whether animals which continue to attack have habituated to the signals, or have experienced hearing damage,
- ADD signals may interfere with animals' communication signals and with passive listening abilities, due to "acoustic masking,"
- Harbour porpoise respond to ADDs by avoiding exposure to the ADD signal by altering normal movement patterns. This could result in permanent disruption of normal movements and appreciable loss of access to habitat,
- Declines in the number of sightings of baleen whales and killer whales in the Broughton Archipelago have been reported and appear to coincide with the introduction of ADDs to that area. It is not clear whether these two events are related; however, observations in Newfoundland indicate that humpback whales may vacate areas where ADDs are operating, and
- Based on the variable effectiveness among farm sites and diminishing deterrence response with time, ADDs are not considered a long-term or a desirable primary method of predation control.

Given these findings, particularly the finding on the inconclusive effectiveness, ADDs present too great an environmental impact to allow their continued use in B.C. Predator prevention through physical control measures should be the priority—see above recommendation respecting "predation prevention plans." ADD use should be phased out over a two-year period to allow some time for salmon farmers to develop and implement predation control plans with a focus on physical predation control measures. Prevention plans should prohibit the use of ADDs. Federal/provincial cooperation regarding implementation of this recommendation will be necessary.

C. “Night Lighting” at Salmon Farms

Several salmon farms in B.C. have been authorized by DFO and MAFF to illuminate their net-cages at night because it shows promise for growing larger fish more quickly, and prevents premature maturation of Atlantics (know as grilsing) and failure of fish to reach normal adult size. These benefits may lead to an overall reduction in production costs for salmon farmers.

The SAR heard concern about this practice, especially from First Nations. The main basis for the concern is that lighting attracts wild fish species such as herring into the net-cages and that the fish attracted are being eaten by farm fish. Another concern is about the potential for transmission of disease to wild fish that are in such close proximity to farmed fish, although salmon farmers would naturally also be concerned about transmission of disease from wild to farmed fish. A further issue is the aesthetic impact of night lighting on nearby residents and recreationists.

Study to date of the biological effects of this practice shows that fish in net-cages do not consume significant amounts of wild fish that may be attracted to the net-cages by lighting. However, limited past research into this interaction, coupled with conflicting anecdotal information, suggests that further scientific study of this issue is warranted. Accordingly, it is proposed that no new authorizations for night lighting at fish culture operations be issued in B.C., pending the results of additional research into this issue. Since this issue is principally of concern to First Nations, they should be involved in the development of study design and monitoring to undertake further work. The existing agreement between the province and the KTFC provides an administrative mechanism for this cooperation to occur in the Broughton, where this issue is most pronounced. Naturally, the industry also must be actively involved in this research initiative.

CHAPTER 9. FIRST NATIONS ISSUES

I. Participation of First Nations in the Provincial Management Scheme for Salmon Farming

The art and cultural objects of coastal First Nations describe the close and special relationship First Nations have had, and continue to have, with the sea and its resources the often referred to “whole” or “oneness.” This relationship not only gives rise to aboriginal rights but guides the perspective of First Nations people and defines their outlook on matters that can affect that relationship. It is to be expected that First Nations would have serious concerns about activities that could potentially impact that relationship or jeopardize their economy, culture and traditions. It is also to be expected, in these times of treaty discussions and evolving definitions of the province’s obligations to First Nations, that the province’s approaches to resource management will also be evolving. These factors led to a process for this review that ensured extensive involvement by First Nations, and they illustrate why meaningful involvement by First Nations in the ongoing management of the resources that the salmon farming industry relies on is being recommended. Throughout the report, recommendations are discussed that are related to First Nations concerns, and these are summarized in this chapter.

First Nations participated in the review through membership on the Review Committee and through direct consultation with the TAT and EAO. First Nations submissions, comments and perspectives regarding salmon farming are presented in Volume 2 of this report. Volume 2 is purposely not summarized here to avoid loss of any meaning or intent and should be read closely to understand the concerns, comments and positions taken by those First Nations that participated in the review. The conclusion that can be drawn from their perspectives is that First Nations have “zero tolerance” to salmon farming in their traditional territories due to concerns about potential impacts of salmon farming on wild resources and their aboriginal rights.

There are a number of reasons for this position including technical concerns. These are discussed in detail in Volume 2.

II. Assessment of Infringement of Aboriginal Rights Through the Tenuring Process

A critical decision for the province to make in managing salmon farming is a determination regarding infringement of aboriginal rights due to the granting of a tenure for salmon farming. The past few years have been significant in the development of the law respecting aboriginal rights. The leading court decisions are summarized by Hillyer¹ for the EAO and

by Braker (Volume 2, Appendix 4) from a First Nations perspective. In January 1995, the Minister of Aboriginal Affairs

*released a policy providing operational guidelines to provincial government agencies in meeting their legal obligations to ensure aboriginal rights are respected on Crown land. The guidelines were developed based on a number of key court rulings, particularly *Delgamuukw v. B.C.* (BCCA, 1993). Aspects of this decision have recently been argued at the Supreme Court of Canada and a decision is pending.*

The BC Court of Appeals (BCCA) decision clarified the nature of the legal relationship between the province and First Nations. Before engaging in, or approving activity on Crown land, the province must determine if aboriginal rights exist in the area and ensure that the proposed activity will not unjustifiably infringe those rights. The province is committed to a policy of exercising best efforts to avoid any infringement of known aboriginal rights during the conduct of its business. Infringement will be avoided where Crown and aboriginal rights can co-exist, either as a matter of fact or as the result of a negotiated settlement.

The Crown Lands Activities Policy outlines the process for dealing with a Crown land application in the context of determining aboriginal rights by asking four questions:

1. Is a right established?
2. Would the proposed Crown action infringe the right?
3. Can matters of conflict be resolved through negotiation?

4. If there is an infringement, can it be justified?

In order for the province to deal with these questions, there must be a mechanism in place for the province to discuss them with the First Nation in whose territory, or in the vicinity of whose territory, the application is being proposed. Assessment of infringement is based on ensuring adequate information regarding the resource that is the subject of the right being asserted. This information will often be in the form of habitat and biophysical resource inventory data and will include traditional use assessment including social, economic and cultural components. This information is necessary before an analysis of the effectiveness of strategies to avoid or mitigate potential impacts to resources subject of the right can be undertaken. Chapter 4 recommends that habitat and biophysical resource assessment data be collected as part of the site assessment by the proponent under the direction of the regional Fish Farm Review Committee. Traditional use information not already accessible through provincial databases may require collection for a specific site assessment.

A. Tenure Renewals and Amendments

If followed, the current policy and process to consider tenure applications will result in an appropriate analysis of potential infringements of aboriginal rights. The Crown land process is applied to tenure renewals and replacements where there is evidence that activities may infringe on aboriginal rights and where the licences (tenures) do not contain specific provisions with respect to renewals. First Nations will also be consulted regarding tenure

amendments, if there is information suggesting aboriginal rights may be affected by the amended tenure.

While the EAO has not reviewed all files for all tenures, it is apparent that the recommended siting standards, designed to protect resources to which there may attach aboriginal rights, will not be met for some existing tenures. For these tenures and tenures which First Nations have indicated infringe their aboriginal rights, there should be a process to assess the potential of unjustifiable infringement prior to the licence being renewed.

Identification of tenures requiring consultations on renewal should be undertaken immediately through the review of existing tenures (recommended in Chapters 4 and 7) and through consultation with appropriate First Nations, so that MELP would have some idea of the number of sites overall that would require further work. This review should focus on those sites identified by the First Nation consulted as requiring an aboriginal rights assessment, as opposed to every site.

The strategy would continue the work that MELP and MAFF have initiated in Clayoquot Sound and should include the Broughton Archipelago. The preliminary review should determine on a site-by-site basis whether:

- consultations with First Nations were undertaken, and/or
- habitat, biological resource inventory or cultural and heritage information was considered as a basis for the aboriginal rights assessment.

The consultations should be undertaken with the First Nations in whose traditional territory the tenure is located. The Broughton Archipelago First Nations have agreed that these consultations would be through the KTFC. This strategy may result in the need to move certain farms to newly approved sites.

This raises the need to sequence steps in the process of reviewing tenures.

The tenure review process could be invoked as tenures come up for renewal, or could deal with tenures in two time groupings (1987–1990; 1991–1993).

Early on in the process, MELP should have an estimate of the demand on the Crown land resource for farm relocation. This should be known prior to new applications being considered.

The Broughton Archipelago falls within the boundaries of the forthcoming Central Coast LRMP. The need to relocate farms should be a consideration during that planning process. As mentioned above, an estimate of the resources needed to relocate farms should be made prior to dealing with any new applications to protect investments of existing tenure holders in farm capital and equipment, and to protect related onshore investment.

It is essential in these processes to consider the vested rights and interests of the tenure holders. Industry will be a critical component during the development and implementation of strategies to deal with review and renewals of existing tenures.

B. New Tenures

The process recommended by First Nations to consider tenure applications is based on the following principles:

1. The relationship between the province of B.C. and the First Nation must be based on respect. This requires full disclosure of information relevant to a decision by the province.
2. As each First Nation is independent and possesses its own rights, the First Nation in whose traditional territory an application for a tenure is made must be consulted.
3. Each First Nation may establish its requirements for consultation.
4. First Nations must be involved in decision-making in a genuine manner on a government-to-government basis.
5. When implementing policies and regulations, the province will recognize, affirm, and respect aboriginal rights.
6. First Nations must be involved in decisions regarding:
 - applications for approvals for new fish farms,
 - changes to existing farms (threshold of change not specified),
 - renewal of fish farm “licences,” and

 - management of fish farms.

Currently, First Nations are involved in decisions respecting salmon farming through the application of the Crown Land Activities Policy, with referral and consultation concerning tenures and licences, and referrals to the KTFC for the Broughton. The process recommended by First Nations for involving them in these decisions is outlined in Figure 1, Volume 2. It is dependent on a detailed proposal prepared by the proponent including: a site plan, operational plan and various management plans including systems for fish containment, escaped fish recovery, fish health management and disease control, waste management and staffing and hiring policies, as well as a site remediation / reclamation plan as necessary for fallowing or when a farm is closed. The proposed process is based on time-lines and invokes dispute resolution processes where conflict arises in the process.

Involving First Nations as members on the Fish Farm Review Committees would ensure that they receive information collected by the proponent, and would provide a mechanism for First Nations to present information relevant to the siting request to the committee. This committee-based approach to a tenure review is similar to the environmental assessment (EA) process established by the EAA and the process in place for reviewing mines that are not reviewable under that Act. For the latter, there are established standing regional committees that consider and review applications. Under the EAA, a project committee consisting of government (federal, provincial, First Nations and local) representatives, reviews an application.

As in the EA process and as recommended by First Nations, any proposed process would require that the proponent submit a well developed proposal. (see Chapter 4). This report recommends that the Fish Farm Review Committee have a primary role in reviewing tenure applications. It should have representation from those managing agencies with an interest in

fish farming (e.g., DFO, MELP, MAFF, MSBTC, MOH) and include representation from the First Nation(s) from the area in whose territory the application is made and local government representatives. The committee would be responsible for ensuring that the proponent submits adequate information for review. The committee-based process is also a good mechanism to link the statutory requirements of the Heritage Conservation Act (administered by the MSBTC) with the First Nations, whose heritage and culture are being assessed.

The proposal would also be referred to the relevant local advisory working committee (see Chapter 4), with local government representatives serving as the information link between the two committees. First Nations may choose to participate on the working committee, as well as the Fish Farm Review Committee. Recommendations regarding notice of applications are also made in Chapter 12.

Parallel to this process, the province must meet its obligation to consult directly with First Nations in whose traditional territory the tenure is applied for, in accordance with the policy, or in the case of a First Nation party to the KTFC/provincial MOU, with the KTFC. Information provided through the Fish Farm Review Committee will assist this process. For Clayoquot Sound, the application would be referred to the Central Region Board. The Regional Manager would take into account the results of First Nations consultations and, in the case of Clayoquot Sound, the decision of the Central Region Board, recommendations of the Fish Farm Review Committee and advice from the local working committee, in coming to a decision. In practical terms, a Central Region Board decision against a proposal will result in the dispute resolution process being invoked and no tenure being issued immediately. These procedures are shown in Figure 11 in Chapter 4.

The policy of the Lands Branch of MELP is to respect the processes established by interim measures agreements and protocols, recognizing that they do not replace the province's obligation to avoid unjustifiable infringement. As pre-treaty agreements and treaties are negotiated, the consultative mechanisms will change and consultations should be conducted in accordance with these agreements.

It should be noted that any person can file an objection under section 63 of the Land Act and request the Minister to hold a hearing prior to a decision being made.

III. First Nations Involvement In Resource Management

The local or “first-hand” knowledge of First Nations with respect to wild resources is in itself a valuable resource that has not been well utilized by agencies managing the resources associated with salmon farming. This information has developed in First Nations over generations due to their unique and direct relationship with their environment, and has often not been accessed when resource decisions were made. The decision-making process with respect to tenures is one mechanism to input this information, but there are others. Because of the First Nations unique relationship with the wild fisheries resources, First Nations should be involved in policy development for the salmon farming industry and participate on the advisory body recommended in Chapter 13.

Many First Nations agencies have been developing highly capable, technically skilled staff (often fisheries staff), who are able to combine the local knowledge of each First Nation with their newly acquired skills. These individuals are often retained by the federal government as guardians or fisheries officers. As a result of this enhanced capacity, combined with the nearness of many First Nations communities to salmon farms, First Nations are in an excellent position to provide support and technical services directly to industry. These services may include farm-related support services (e.g., packing and transporting fish, feed, and equipment) and technical services such as environmental research, sampling and monitoring.

First Nations are similarly in a position to assist governments with research, audit and enforcement roles, and to assist governments and industry with the implementation of regionally developed escape recovery plans. Accordingly, members of First Nations could be relied on to provide certain of these program functions for government and, due to location, provide economic efficiencies. Consideration should be given to providing training programs for First Nations, as needed.

Since many First Nations are involved in fisheries enhancement and the harvesting of wild stocks, they should be offered training in fish health and disease identification in wild stocks, in order to provide data on fish disease surveillance to the common database recommended in Chapter 6.

There is some limited direct employment of First Nations in the industry at this time, working on farms, packing and transporting fish and working in fish processing. First Nations have had little direct involvement as farm owners, but some limited interest has been shown by a few First Nations in direct participation in the industry through farming.

CHAPTER 10. MANAGING RISK AND UNCERTAINTY

I. Uncertainty

The review received criticism for its failure to answer unequivocally all of the questions and concerns raised during the review. The TAT was tasked with evaluating all existing scientific literature, research, and observational information currently available and providing their best interpretation of these data. Input from the RC and members of the public ensured that the TAT's review and interpretation were comprehensive. The Environmental Assessment Office was not mandated to conduct primary research, and even the most exhaustive review of already existing literature is limited to the current state of knowledge for the issues as at the date of the publications. There remains varying levels of uncertainty around some of the issues addressed by the review. This must be considered when recommending future management directions and research needs.

The positions taken by individuals and organizations during the review relate to their willingness to accept differing levels of risk in the face of uncertainty. Proponents of the industry point to the conclusions of the TAT that there is a low overall risk to the province from the existing industry as being a 'green light' for industry expansion. The most vocal opponents of open net-cage salmon aquaculture point to the remaining uncertainty and argue that the burden of proof should be on industry to show that there are no risks to the marine environment. They regard the failure to prove negative impacts to be irrelevant, given information gaps, and suggest that the inability to completely disprove those negative impacts justifies a shift to closed-containment grow-out systems. Other approaches fell between these two extremes.

The inability of science to eliminate uncertainty around an issue is not unusual. Scientific research rarely eliminates all uncertainty, but more narrowly defines its boundaries. In the face of uncertainty, researchers continue to gather information, but government decision-makers must choose a course of action. Delaying action in the hope that new information will resolve, or at least reduce, the level of uncertainty is itself an interim decision. Decisions are needed that protect and nurture a richly diverse natural environment, yet enable economic progress.

II. Precautionary Principle, Preventative Management and Adaptive Management

Several members of the RC and public recommended that government invoke the precautionary principle when dealing with the uncertain consequences associated with salmon aquaculture. Most definitions of the precautionary principle include the notion that when the outcome of an activity is uncertain, the potential negative effects of that activity

need to be considered and measures taken to avoid them. There is no consensus on how to apply the principle to decision-making under conditions of uncertainty.

Since the principle has a range of interpretations, perhaps the best way to apply it is as a guiding principle. It should encourage, or perhaps even oblige, decision-makers to consider the potential for harmful effects of activities on the environment before they approve those activities. The Provincial Land Use Charter, which reflects provincial resource use policy, recognizes that the human understanding of nature is incomplete and commits government to attempt to anticipate and prevent adverse environmental impacts and exercise caution and concern when making land and resource decisions.

Until information is at a level that allows consistent, accurate prediction of the impact of an activity, measures are relied upon to ensure a specific outcome is prevented. For example, while it is important to fully understand the impacts of escaped farmed salmon on wild salmon, it is probably more important to prevent their escape to avoid unknown impacts. Similarly, while it is important to fully understand the implications of disease in farmed fish, it is probably more important to prevent disease. Many of the recommendations of this report are aimed at impact prevention or avoidance when the full implications of an impact are not known.

Directly related to the precautionary principle is the concept of adaptive management. Adaptive management can be defined as linking science with management and implementing management in a manner that predicts and allows for change as the science changes. It acknowledges uncertainty and then sets out to deal with it. Adaptive management functions by first identifying gaps in knowledge and then linking defined experimentation and monitoring efforts to fill in those information gaps with adjustments in management and regulation. Conclusions will determine the level of prevention necessary.

By adaptively managing the salmon aquaculture industry, government can proactively address existing uncertainty, reduce risk and allow for sustainable development of the industry in B.C. Fundamental to successful adaptive management are focused research initiatives and ongoing monitoring to fill in information gaps and determine if management adjustments are indicated. The other component, as mentioned above, is to manage in a precautionary manner to avoid or prevent negative effects. Many of the TAT recommendations were based upon their best interpretation of the existing information and were qualified by identifying the need for further focused research and monitoring. Further, the TAT acknowledged the validity of adjusting their recommendations based on the findings of that research and monitoring.

The need for increased protection against even the remote possibility of a catastrophic event was also raised during the review. Some people argued that the results of further research and monitoring may not provide the answers quickly enough, and that there need to be

contingency measures in place to deal with any major negative impacts on the coastal environment. In addition to prevention management, the measures most often suggested include the use of increased insurance and bonding schemes to ensure that there are adequate funds to mitigate the effects of a catastrophe.

The following sections discuss these three measures (research, management program implementations and monitoring, and insurance / bonding schemes) for addressing risk and uncertainty in the management of salmon aquaculture in the province.

III. FOCUSED RESEARCH NEEDS

As discussed above, continued research that is focused on filling in information gaps is crucial to adaptively manage and to reduce uncertainty over time. Research efforts must be prioritized to ensure the most effective use of limited resources. Successful research which increases knowledge is dependent upon the cooperative efforts of industry and government. Since both government and industry will benefit from further research into salmon aquaculture, cost-sharing is necessary. Whenever possible, independent research institutions and consultants should be involved, recognizing that as government resources decrease, reliance will shift to industry to fund much of the work.

Table 17 prioritizes the research recommended in this report by outlining a time frame for undertaking specific research efforts.

Table 17: Suggested Scientific Research, Technological Development and Resource Inventory Priorities

Issue 1 Year Within 3 Years			Immediate Ongoing	Within Future
Escaped Farm Salmon	<ul style="list-style-type: none"> • Investigate the feasibility of genetic/physical marking of Pacifics as a way to monitor genetic impacts of escapes. Investigate Norwegian marking programs for applicability to B.C. • Conduct experiments to distinguish whether chronic net pen losses are due to escape rather than undocumented mortality. • Determine a practical time frame to shift to production of all female Atlantics 	<ul style="list-style-type: none"> • Pursue technologies to produce all-female and non-reproductive Atlantic stock, to determine feasibility of making these technologies mandatory. 	<ul style="list-style-type: none"> • Further develop domesticated Pacific broodstock that exhibit genetic and behavioral characteristics that would make interbreeding with wild stocks unsuccessful. • Continue to study interactions (e.g. genetic, competition, risks) between wild and escaped farm salmon. • Managing agencies to actively monitor research of known researchers from universities investigating potential interactions/behaviours of escaped salmon. • Province (MELP/MAFF) and DFO to contribute to ongoing research into vaccine development. 	<ul style="list-style-type: none"> • Research the use of chemicals to artificially imprint farm salmon in order to attract them to specific areas.
Fish Health				cont...

Issue	Immediate	Within 1 Year	Within 3 Years	Ongoing	Future
Waste Discharges	<ul style="list-style-type: none"> Assess the viability and safety of bivalves at beaches 	<ul style="list-style-type: none"> Conduct research for a full farm production cycle, as a basis for establishing a discharge standard Develop a quality control system for phosphorus discharge to aquaculture basins 		<ul style="list-style-type: none"> Continue to refine the MAFF discharge and siting model to incorporate climate change impacts, distribution, and aquaculture 	<ul style="list-style-type: none"> Undertake studies of regional flushing/ oxygenation and bivalve waterways Undertake pilot projects Experiment with integrated aquaculture
Coastal Mammals and Other Species	<ul style="list-style-type: none"> Conduct further research into the effects of night lighting, including effects on species outside of net pens, as a basis for establishing final provincial policy on the practice of night lighting at salmon farms. 				
Salmon Farm Siting			<ul style="list-style-type: none"> Identify and classify the relative "importance"/"significance" of anadromous fish streams, as basis for refining siting criteria. 	<ul style="list-style-type: none"> Define areas of sensitive fish habitat (marine), sensitive marine wildlife habitat, critical and important recreation sites and features, archaeological and cultural heritage sites and features, and First Nations coastal use areas. 	
Alternative Technologies	<ul style="list-style-type: none"> 	<ul style="list-style-type: none"> Initiate pilot projects to promote development of closed circulating marine systems in B.C. (see Chapter 11, Recommendation 43). 			

IV. Management Program Implementation and Monitoring

In addition to pursuing new solutions through research, it is necessary to continually assess the adequacy of current management programs. Monitoring, or the ongoing collection of information, is crucial in this regard. The collection of standardized data continuously over time, allows an increasingly refined understanding to be developed. To determine the effectiveness of existing measures, it is important that information be collected and analysed over an adequate time frame to evaluate whether or not the activity is meeting the set standard. Many of the individual recommendations of this report include the requirement for ongoing monitoring as part of a performance-based program as a measure of effectiveness. Refer to Chapters 4-8 for specific recommendations regarding changes to management programs and monitoring.

V. Insurance and Bonding Schemes

*Some review participants proposed that the risks of ecological damage to wild salmon due to salmon farming, and the associated risks of economic loss to those whose livelihoods depend on the wild salmon fishery, should be mitigated through a requirement for the salmon aquaculture industry to post a sizeable financial bond that would provide a secure source of funds to remediate ecological problems and compensate for economic losses. This proposal arises primarily out of a concern about the potential for a collapse in wild salmon stocks caused by disease transfer from farmed to wild fish. The Norway experience is cited frequently as an example where the importation of salmon corresponded with a change in the rate of detection of the parasite *Gyrodactylus* in Norwegian rivers. The original introduction of infected smolts to Norway was for the probable purpose of enhancing wild stocks. Since broodstock for the hatcheries was taken from the wild stocks and moved into hatcheries, hatcheries became infected. Many hatcheries provide stocks to the salmon farms and for release into the wild for enhancement.*

*Officials in Norway responded to the *Gyrodactylus* infection with a parasite control program consisting of killing all fish in the affected rivers through the introduction of the chemical rotenone. This chemical treatment kills fish, but does not destroy fertilized eggs in the stream*

bed. The question of whether or not the lack of previous detection of the parasite reflected a recent introduction of it from importation of Atlantic salmon into Norway (1975), or inadequate disease surveillance in Norway, continues to be debated. Also debated is whether or not it is appropriate to react to an outbreak with such drastic measures. Some feel that diseases should run their course as a mitigation measure. In B.C., the importation of live smolts, the host for this parasite, is prohibited for salmon enhancement programs or commercial salmon culture. Despite the differences between the Norwegian and B.C. situations, some groups interpret this experience as a type of occurrence that could affect B.C., and would like an assured source of funds to be available to respond to that possibility.

There are precedents in other economic sectors where security guarantees, normally in the form of a financial bond or approved letter of credit, are required from developers by government in order to ensure the availability of money to address problems of non-performance, clean-up, or reclamation. For example, mining developments are normally required to post a bond to ensure the availability of funds for mine reclamation or to guarantee funds for ongoing post-reclamation onsite treatment costs. There is currently about \$150 million held in bonds for these purposes from mining companies operating in B.C. The energy sector in B.C. is also required to provide drilling reclamation deposits for a similar purpose. The total value of bonds posted by energy companies in B.C. is under \$10 million. The B.C. salmon farming industry itself currently maintains a blanket performance bond of \$25,000, arranged through the BCSFA, to cover site clean-up costs in the event of an operator abandoning a farm site and leaving government with the responsibility to remove the improvements. In all cases, the bonds relate to reclamation at the site, and reflect an amount that can be estimated with some degree of accuracy.

Although these precedents and examples exist, the proposal to require industry to guarantee a pool of funds to remediate a potential ecological disaster and to compensate those affected must be considered in light of a number of factors.

A. Degree of Risk

The review has concluded that although the probability is not zero, the likelihood of the importation of exotic pathogens in connection with salmon farming activities is low, as is the probability of disease outbreak due to farm-wild fish interactions. Although the consequences of a major disease outbreak could be extreme, the estimated low potential for salmon aquaculture to cause an outbreak would make it difficult to impose a requirement for a remediation fund. A far better risk management strategy would be to focus on prevention through the consistent application of well-designed importation policies and protocols, and sound husbandry practices.

B. Causation

If there were to be a major disease outbreak in wild stocks, it would likely be difficult to definitively say whether or not that the disease outbreak was caused by salmon aquaculture. The tools to accurately trace a disease in the open aquatic environment to its place of origin are limited although they will expand with the implementation of recommendations in this report regarding fish disease surveillance. Unless there was strong evidence connecting a disease outbreak in farmed salmon to a disease outbreak in wild salmon, the use of such a fund could not be justified. This report recommends disease surveillance and application of the provisions of the Animal Disease Control Act. This approach would allow sources of diseases to be known and the costs associated with government control of the disease outbreak to be recovered.

A legislatively based mechanism to respond to emergency situations exists in the Environment Management Act. The Act contains provisions to address emergency measures through powers granted to MELP. Where the Minister considers an emergency to exist, the Minister may declare an emergency and that steps be taken to prevent, lessen or control any hazard. The costs for the response are recoverable under the legislation as a debt through court action against those whose act or neglect caused or who authorized the events that caused the emergency. These powers currently exist for the use of government, should the unlikely scenario of an environmental emergency arise in connection with salmon farming.

C. Size of Fund

The potential scale or magnitude of the impact of this type of scenario is unknown. The often cited example of rivers in Norway treated for the disease Gyrodactylus, discussed above, involved a ten-year program designed to eradicate disease from rivers where hatcheries supply parr (pre-smolt salmon) to fish farms and to wild stocking programs. The Norwegian approach of chemical treatment is a very aggressive disease management strategy. A more likely strategy might be to allow the disease to run its course (if salmon were infected) and subsequently restore the run, provided that no non-migratory fish were impacted. The size of bond or contingency fund appropriate to redress the problem and to compensate affected parties would have to be based on potential losses to users of the run and the cost of restoration. Direct costs are recoverable as outlined above.

D. Sectoral Equity

There is the issue of equity with other economic sectors. If the B.C. salmon farming industry was required to maintain a contingency bond of this nature, then arguably all economic sectors that present any risk of off-site, external environmental impact—potentially including the mining, forestry, energy, agriculture, and the automobile industries—should be required to do the same. There are many examples of mitigation and compensation plans through

which project developers bear the cost of rehabilitating lost habitat or resources where loss is a direct result of the development or activity. To date, no disease outbreak in the wild fishery in B.C. has been conclusively shown to have originated from salmon farming, making it difficult to apply the principle fairly.

E. Bearing the Cost

The economic impact on the salmon aquaculture industry must be considered. While the cost of bonding could be borne by the entire B.C. industry, possibly through a production levy, and administered by the BCSFA, the size of B.C.'s industry is small.

If, through further information collection, it was determined that salmon aquaculture poses a major risk to B.C.'s native salmon stocks, then far more direct, immediate and preventative action would be necessary, rather than to simply mitigate it through an 'after-the-fact' funding scheme. In the short term, MAFF should measure the adequacy of the industry bond of \$25,000 for reclamation costs, based on today's costs of doing reclamation work, and increase it if necessary.

The focus of the recommendations in this report is:

- further research and monitoring to fill information gaps and to determine the effectiveness of performance standards, and
- implementation of risk prevention programs and adaptive management.

The costs to industry to respond to these will be significant and will likely affect industry competitiveness, but allocating funds to these areas, especially implementing high standards for production and disease surveillance, is critical and should be where industry funds are directed at this time.

CHAPTER 11. ALTERNATIVE SALMON FARMING TECHNOLOGY

For the Environmental Assessment Office to comprehensively consider all recommendations brought forward in the SAR, it was important that an assessment be undertaken of the general state and availability of alternative technologies to B.C.'s predominantly used floating marine net-cages. As outlined in the direction given to EAO by the Ministers of Environment, Lands and Parks and Agriculture, Fisheries and Food, the EAO returned to the Ministers to confirm the addition and assessment of this information, which was outside the original terms of reference.

I. Introduction

The primary reasons for exploring alternative salmon farming technologies are the desire to:

- control environmental impacts,
- improve efficiencies in culture methods, and
- **augment opportunities to site salmon farms in locations that result in reduced coastal use conflicts.**

A general assessment of existing and developing marine or saltwater salmon aquaculture technologies that may be applied on a commercial grow-out basis was prepared as part of the review (see Volume 4, Part 4). These technologies can be categorized as follows:

- exposed offshore open marine systems,
- closed circulating marine systems, and
- **land-based saltwater systems.**

For each category, the SAR assessed:

- the current state and technical feasibility of the technologies,
- the direct environmental implications for the employment of the technologies, and
- **the economic feasibility of employing the technologies.**

The main advantages and disadvantages of each technology were summarized, and recommendations on the use of technologies in B.C. were derived from the analyses.

The assessment relied on information available from current practical experience. This involved a review of the literature and contacts with involved companies, governments, and organizations worldwide. It relied on the advice from those with experience and expertise working in the field and providing industry services. The direct environmental implications for the employment of the technologies were extrapolated from the results of the review, but

did not involve primary data collection or detailed analyses. Detailed process design and cost estimate for a land-based re-circulating salmon rearing facility in B.C. were conducted by Simons Environmental of Vancouver, B.C. and included in this report (see Volume 4, Part 4).

A summary of the main economic, environmental and social advantages and disadvantages associated with various salmon farming technologies is presented in Table 18.

Table 18. Analysis of Alternative Technologies for Saltwater Salmon Grow-out.

System Type	Advantages	Disadvantages
Exposed Offshore Open Marine Systems	<ul style="list-style-type: none"> • proven commercial viability • avoids / reduces environmental issues associated with near-shore coast (e.g., benthic smothering, potential nutrient loading of inshore waters, predator interactions) • less conflict with competing coastal resource users • potential for many new sites to become available for the industry • higher quality rearing environment, leading to a potentially healthier, higher quality product 	<ul style="list-style-type: none"> • changes required in farming methodologies • investment in new engineering and new capital • changes required in industry corporate focus • potential for navigational conflict • uncertain government policy and regulatory environment • possible redirection of economic benefits associated with processing and services
Closed Circulating Marine Systems	<ul style="list-style-type: none"> • highly controlled, more optimal rearing environment for cultured fish • with solid waste collection and treatment, some coastal environmental issues addressed • decreased interactions with predators and level of escapes 	<ul style="list-style-type: none"> • economic and technical viability unproved • continuing competition for space with other coastal resource users • flow-through nature of design (high volume intake with untreatable effluent) does not eliminate many environmental concerns • investments in more expensive capital required
Land-Based Saltwater Systems	<ul style="list-style-type: none"> • highly controlled, more optimal rearing environment for culture fish • with treatment technology, avoidance of potential deleterious impacts on the marine environment associated with waste discharges • easier, safer working environment • limits or eliminates escapes and interactions with predators 	<ul style="list-style-type: none"> • poor record of economic success - commercial viability doubtful at this time • extremely high capital and energy costs • treatment of solid wastes and waste water difficult, although technology is emerging • environmental issues associated with water intake and effluent still evident without recirculation/ treatment • highly restrictive siting requirements - provincial availability unknown • conflict with upland property users expected

II. Exposed Offshore Open Marine Systems

“Offshore systems” operate in locations that are exposed to relatively harsh environmental conditions, specifically large waves and potentially high currents. The primary benefit of these systems is the opportunity to grow fish in a consistent, higher quality water source with greater flushing rates than are found in more sheltered locations. “Offshore” can mean a few hundred metres or a few hundred kilometres from the shore.

Development of offshore operations has included surface and submersible cages. More specifically, bottom-mounted submerged cages, surface-operated but bottom-moored nested cages, large single cages, fully submersible cages, and surface-operated, moored and flexible systems have been developed.

Various offshore cage designs are technically feasible and operate commercially throughout the world. There are no obvious prohibitive barriers to the use of these systems on the B.C. coast. There are, however, cost implications to the industry. There are capital investment costs, and, in many cases, new culturing methods and procedures would have to be employed. The additional availability of offshore sites, however, may provide a means for industry expansion, given the limited availability of more sheltered locations. The higher quality rearing environment found in many exposed locations, among other factors, may result in higher productivity, helping to offset capital and operational costs, and potentially allowing the industry to remain profitable.

By moving away from more sheltered locations, the industry could benefit from fewer conflicts with other competing coastal resource users and interest groups. There is, however, the potential to lose associated benefits to coastal communities for processing work, if better product distribution services afforded by larger centres become readily accessible. Moving to more exposed locations may allow for a greater regional concentration of the industry. The patterns that have evolved for the wild fish industry could repeat for salmon farming, if large centrally located offshore facilities were developed with concentrated onshore agglomerations.

Some questions of possible environmental impacts associated with working offshore would also need to be studied further, although there are some clear environmental advantages to moving away from near-shore sheltered locations. Benthic smothering, potential enhanced nutrient loadings, and predator interactions would all be lessened. The better rearing environment which can be offered by open ocean locations may reduce the need for medicated feed. There may be a greater chance of a large-scale escape event due to structural failure or collision with a vessel, but with the proper engineering and safety precautions, these risks can be reduced.

To facilitate the adoption of offshore systems, governments would need to clarify the management regime for offshore aquaculture. Siting decisions and industry management, for many aspects, may come under federal jurisdiction.

In conclusion, offshore open marine systems are currently operating commercially in other parts of the world for the production of salmon. Many systems are available and are feasible both technically and economically. The salmon aquaculture industry in B.C. may find it desirable to expand its operations to more exposed, offshore locations, given the restricted availability of suitable near-shore sites and the environmental benefits. Due to the potential of many exposed offshore marine sites posing unique management challenges to government agencies, clarification on jurisdiction and the policy and management regime is required.

III. Closed Circulating Marine Systems

Two main types of designs have been conceived for closed circulating floating marine systems: a closed-wall cage, and a floating raceway. The first type resembles the traditional floating net-cage structure, with the exception that an impermeable membrane is used in place of a net, and a pump with an adjustable intake directs water into the cage with a passive outflow on an opposing end of the system. Closed-wall cages have the potential of being further modified by devising a system of solid waste collection from the bottom of the cage. The floating raceway has essentially the same elements as the closed-wall cage, but with a linear configuration. Although these systems are 'closed', in the sense that an impermeable membrane separates the fish from the surrounding marine environment, they are still flow-through systems.

Closed, circulating marine systems are becoming technically feasible for salmon grow-out. However, some components require further development and refinement to fully realize the benefits of the system. Commercial feasibility has not yet been demonstrated.

Environmental benefits are the encouraging aspects of this technology. Compared to traditional floating marine net-cages, the farmer can more readily control the growing conditions for the fish stock, potentially increasing productivity. Solid wastes can be collected and treated, although the technology requires further development. Most water flows through the systems. Water effluent is still discharged untreated into the marine environment. Predation and escapes are virtually eliminated. These benefits are not achieved without other use offsets. For example, conflicts with other coastal resource users which compete for space would continue, and may even increase if aquaculture facilities are allowed to move into more sheltered locations. Due to the flow-through design of the systems, some environmental concerns, such as the potential for disease transfer, are not addressed. A high volume of water is required, which may have an effect on plankton or on larvae and juveniles of other species.

In conclusion, closed circulating marine systems have been developed, but require further technical refinement. They are not proven to be commercially feasible and further work is required to shift from an experimental to a commercial operational phase. B.C. would benefit from pilot projects to promote the further development of these technologies from experimental to operational design. Research and development emphasis is needed on the reduction of social and marine environmental impacts and risks associated with salmon aquaculture (based upon the five key review issues), and on improving production conditions for the farmer. Pilot projects need to focus on developing economically viable farms which impose fewer environmental and social impacts than those of traditional floating marine net-cages. Future Sea Farms, in cooperation with DFO, are currently monitoring their test farm located near the Pacific Biological Station in Nanaimo. The information generated from this monitoring program should be considered when developing pilot projects.

Research and development costs to take technology from an experimental design phase to a commercially operational phase can be extremely high. Industry should be encouraged to establish an industry-wide fund for research and development purposes generally, through the levy of its producers to draw from to participate in this development. B.C.'s Farming and Fishing Industries Development Act provides a mechanism for such a levy system. Currently the wild salmon harvesters pay a levy of 0.5 per cent of the price paid to them to the BC Salmon Marketing Council. Such a fund would provide industry with core funding for developmental work but place industry in a position to participate in government-partnered programs for matched funds, when available. It would also provide assured funds for industry contribution to the research outlined in Chapter 10.

IV. Land-Based Saltwater Systems

In the most basic form, land-based saltwater grow-out facilities consist of deep water ocean or saltwater aquifer intakes, pumps and pipelines, saltwater ponds, effluent structures and site buildings. With increasing sophistication, other components may be added, including oxygenation, effluent clarification, treatment of sludge, removal of nitrogenous waste, disinfection with ozone/ultraviolet, temperature modification and recirculation. Generally, these components increase the capital cost and operating complexity of the facility, but improve control of the husbandry environment and reduce impact on the environment. Most of these components are essential for growing salmon in a B.C. context.

Many environmental concerns can be answered with use of a land-based system with recirculation technology. Emerging technology may be able to effectively treat large volumes of solid waste and waste water, while subsequently reducing the flow-through requirements. Interactions with predators and the risk of escapes can be virtually eliminated. With disinfection, the potential for the transfer of a disease agent between farmed and wild stock is greatly reduced. With ozonation of the effluent, it is expected that much of the antibiotic residues from the farm would be effectively broken down. The highly controlled rearing environment can provide near ideal conditions for the farmed fish.

The siting requirements for a land-based facility are very restrictive, and are perhaps the most discouraging aspect of this technology. The need to locate near the shore and near services (road, power), where land values tend to be high, will further increase costs. High capital and operating costs can be potentially overcome given the appropriate institutional or financing conditions, but there are severe limitations due to the physical characteristics of the land required (i.e., large flat location near sea-level, with close, deep ocean water source). Such land, near the necessary services and supporting infrastructure, may be of limited availability in the province. The potential for conflicts with adjacent property owners, given the industrial and large-scale nature of such an operation, can be expected to be significant.

A. Cost Estimate for a Land-Based Salmon Rearing Facility in British Columbia

Simons Environmental (Vancouver, B.C.) produced for the SAR a process design and cost estimate for a hypothetical land-based Atlantic salmon rearing facility on the British Columbian coast (see Volume 4, Part 4). The design assumed a 1000 MT/yr production capacity, with recirculation and water treatment technology, and stocking densities of 30 kg/m³ and 50 kg/m³. Specifically, the process design allowed for primary treatment of wastes (solid and water), aeration, disinfection, nitrogenous waste removal, and 90 per cent water reuse. The full report should be referred to for more specific information on the design and the assumptions that defined the analysis.

The estimate for the current capital costs of the facility was \$21-27 million (CAN), with additional operating costs of \$11-13 million (CAN) (depending on assumed stocking densities). This leads to a required break-even price of \$11.19 /kg (\$5.09 /lb) for salmon produced with a stocking density of 50 kg/m³, and \$12.85 /kg (\$5.84 /lb) for salmon produced with a stocking density of 30 kg/m³. Given the assumptions used in the analysis and the current market price for salmon (approximately \$5.50 /kg or \$2.50 /lb), a land-based salmon culture facility is not economically feasible at these

market prices. Estimated operating costs alone are greater than gross income by approximately 5 per cent. The authors do note, however, that the high degree of variability and the uncertainty involved in many of the analysis variables may mean that under certain circumstances a facility could be profitable. Given the uncertainty of using an unproved design and technology, the poor track record of land-based facilities in other parts of the world, and the likelihood that salmon prices will remain stable or even decline, such a venture would represent a significant financial risk if not subsidized in some way.

The analysis assumed stringent requirements for siting (12.5 ha of flat land, mainly for locating waste treatment ponds, immediately adjacent to sufficiently deep salt water meeting specific quality standards, and with access to infrastructure). The cost of land was not factored into the above cost estimate. Although the analysis of this technology was unable to investigate the availability of appropriate sites, it is believed that land availability and costs would represent a very difficult challenge to constructing a land-based facility in B.C. The land requirements could be reduced with investment in more capital intensive and expensive waste treatment technologies (e.g., aeration in stabilization ponds, activated sludge).

In conclusion, worldwide experience to date, specifically in Scotland, Norway and Iceland, and an examination of the available technology have shown that the use of land-based saltwater systems for salmon grow-out production is not at present commercially feasible in B.C. due to a number of factors. First, high capital and production costs mean subsidization would be necessary. Second, the siting criteria which must be satisfied are highly restrictive and such land may not be readily available and affordable. Third, the use of recirculation technology on a large scale is believed to be necessary to make use of a land-based system truly acceptable and desirable in B.C. Appropriate recirculation technology is emerging, but is not yet proven in commercial application. Although land-based saltwater systems would effectively further reduce many of the environmental and social risks associated with salmon aquaculture, they are not currently feasible. If this technology is pursued in this province, priority should be given to utilizing it for growing and securing broodstock. Broodstock grown from imported eggs could be closely monitored and effluents treated in such a system.

CHAPTER 12. DISPUTE AVOIDANCE AND RESOLUTION

Past provincial inquiries into the B.C. salmon aquaculture industry, and this review, are evidence of the substantial controversy and conflict that continue to surround the industry. Even with adoption of the recommendations contained in this report, which are aimed at preventing and mitigating impacts and conflicts, it is inevitable that future disputes will arise in connection with salmon farming. These may originate from regulatory decisions by resource management agencies, such as site tenuring and operational licensing decisions, or disputes may occur over concerns about operational practices and performance at individual salmon farms. Figure 13 shows the types of disputes that may potentially arise in connection with salmon aquaculture in B.C. Mechanisms are needed to prevent disputes from arising and to deal with these kinds of conflicts in an efficient, fair and effective manner. The following sections describe the possible origins of disputes and provide recommendations respecting potential responses to dispute issues.

Figure 13. Potential Types of Disputes Respecting Salmon Aquaculture

I. SITE TENURING DECISIONS

The Land Act is the provincial statute under which salmon farm site tenure decisions are made. Chapter 4, Section 2 of this report indicated that the Land Act and the MELP salmon aquaculture policy both assign wide discretion to MELP staff in making siting decisions, and provide limited opportunities for applicants to query or appeal siting decisions made by MELP. The SAR heard frustration with the current lack of opportunity for the public to influence salmon farm siting decisions. Concerns were raised that:

- public comments provided as part of the site tenure application process go unheeded,
- there is limited opportunity to file objections to siting decisions once they are made, and no procedural opportunity for input into whether or not existing salmon farm tenures should be replaced when they expire, and
- there are not effective procedures in place for reconciling inter-agency disputes over siting decisions.

These criticisms of the existing management system are significant, given that salmon farm siting decisions represent important decisions in the sense that siting is a main way to mitigate against impacts and conflicts. If a salmon farm is properly sited in relation to other environmental resources and interests, then impacts and conflicts, and thus disputes, are normally few and manageable. The opposite is true where farms are sited inappropriately.

Given the importance of siting decisions, it is evident that concerns with existing arrangements need to be addressed. Increased inter-agency coordination in salmon aquaculture decision-making, integrated coastal zone planning, adoption of clearer and refined siting criteria, strengthened public and First Nations participation in siting decision-making, and improvements in the information base upon which siting decisions are made (see siting recommendations in Chapter 4 and recommendations specific to First Nations in Chapter 9) should all contribute to resolution of the concerns through dispute prevention. Additional mechanisms are needed, however, to prevent and address siting-related disputes, including disputes between applicants and MELP siting decision-makers, as well as between MELP and third parties who object to siting decisions made by MELP. These mechanisms need to reflect basic principles of administrative fairness.

A staged procedure is needed.1 First, the public should receive sufficient notice of pending salmon farm siting decisions. At present, aside from referrals to selected interests, the only official notice to the general public that a salmon farm is being proposed in a particular location is an advertisement taken out in the local press for a brief period by the proponent, indicating an intention to apply for a disposition of Crown land.

Notice of application must also be posted at the site being applied for, but practically speaking, this does not do much to promote public notice of pending applications in remote and inaccessible locations.

1 This assumes situations where an applicant is seeking out a site, as opposed to the planned site pre-selection process identified in Chapter 4.

Second, there should be a clear procedure for concerned parties to request a hearing. Presently, there is opportunity under section 63 of the *Land Act* for the Minister on receiving an objection to the disposition from any person, at his or her discretion, to appoint a person to hold a hearing prior to disposition of an application. The individual appointed to hear the objection makes recommendations to the Minister, as a basis for the Minister's final decision on the application. Once a siting decision is made, whether based on a hearing or not, MELP should be prepared to provide written reasons for the decision. The Ministry should also be prepared to review a decision complained of internally to ensure all considerations were weighed in making the decision. Policy clarification regarding this should be developed.

Third, there should be public notice of actual decisions on whether or not particular site applications are approved by MELP. At present, there is no requirement or procedure to do so. It is conceivable that the presence of a salmon farm may be the first notice that local interests receive of a siting decision.

Finally, there should be at least some opportunity for appeal of siting decisions to an independent third party. As a matter of administrative law in B.C., any person can apply to have a decision judicially reviewed for failure to meet procedural fairness and natural justice. Also, rights of appeal to the B.C. Supreme Court on questions of law arising from an order of the Minister regarding disputed applications are statutorily provided to persons affected by the order (section 64 (1), Land Act).

These provisions offer remedies to address administrative fairness issues, provided that good site application notice procedures are followed, that third parties are made aware of their procedural right (under section 63 of the Land Act) to raise a formal objection to a siting application before a tenure is issued, and that valid reasons for a decision are provided on request or, with a policy change, are routinely provided when the decision is made.

With respect to notice, existing provisions could be enhanced in a number of ways:

- proponents could be required to sponsor one or more local open house events to explain their proposals and solicit input,
- proponents could be required to meet with "local working committees" (as proposed in Chapter 4) to discuss their proposals,
- the procedural right of third parties to file objections with the Minister, in addition to the standard opportunity to provide comments on applications in response to newspaper notices, could be made clear in salmon farm site posting notices and in newspaper advertisements of site applications, and
- a listing of all site tenure applications and their up-to-date status could be maintained on an internet web-site.

With these innovations, there would be significantly increased confidence that the views and priorities of all interested parties were thoroughly canvassed as a basis for site decision-

making. This should lead to informed and balanced decisions, with dispute prevention as a focus, given the available remedies.

II. Operations-Related Licensing and Permitting Decisions

Aside from site tenure licences, salmon farmers must obtain a variety of other government licences and permits to conduct specific activities at the farm site. These are described in Chapter 3, and primary operations-related licensing and permitting requirements are shown in Table 11. Included here are requirements to obtain: an aquaculture operating licence from MAFF; a waste discharge permit from MELP, where a farm size threshold is crossed; a permit to import salmon eggs or to move live fish within B.C.; and a licence to control marine mammal predators by shooting them if other predation control methods have been ineffective.

As with any regulatory decisions, it is conceivable that disputes may arise in connection with these licensing/permitting decision-making processes. These may arise between the applicant and the regulatory agency, or third parties may object to licensing decisions that are made by regulatory agencies. With the exception of processes pertaining to permits under the Waste Management Act, there are presently only limited opportunities for public notice and review/appeal of operations-related regulatory decisions.

As proposed for salmon farm siting decisions, it is suggested that public notice of operations-related licensing and permitting decisions, and opportunity for a public comment period, need to be improved. One mechanism to deal with this is to encourage concurrent consideration of the tenure application and key provincial permits such as the aquaculture licence.

With current internet technology, it would not be difficult or expensive to maintain a web site containing a listing and status of all applications for salmon aquaculture licences and permits, including site tenure applications as discussed above. With this innovation, the interested public, industry and government agencies could all quickly access up-to-date information on the status of all salmon farm licence and permit applications and approvals. This would greatly improve the openness and transparency of the management of the industry. MAFF, as the lead provincial agency for salmon aquaculture, would be in a good position to develop and maintain an internet web site containing this type of information.

III. Operational Practices at Farm Sites

Some SAR participants expressed frustration that once a salmon farm is in operation, there is no effective means to influence how it operates and no independent office to register complaints about poor performance. It is also generally felt that agencies do a poor job at monitoring licensees to ensure compliance with terms and conditions contained in licences and permits.

At present, there are two main means by which the public may instigate a review of performance at a salmon farm. They may complain to the appropriate licensing agency, and

this may lead to an investigation of the complaint in relation to the licence / permit terms and conditions or other regulatory standards that the farmer must operate within. If it is found that the operator is out of compliance with required provisions and standards, then the regulatory agency has a legal means for enforcing the requirements. Ultimately, the agency may cancel the licence or decide to not renew it upon expiry.

Another avenue for the public to register a complaint about operational practices at a salmon farm is to follow the procedures set out in the recently enacted Farm Practices (Right to Farm) Act. Under these provisions, individuals that are concerned about a salmon farming impact (e.g., noise, light, odour, appearance) at a particular farm are encouraged to contact the regional offices of MAFF, where an attempt is made to resolve the concern at the local “neighbour” level, and where potential solutions are discussed with both the farmer and the concerned individual. Alternatively, individuals may file a formal complaint with the independent Farm Practices Board that has been established under the Act. The board may initially try to resolve a complaint through a settlement process which may include the use of ministry experts, peer advisors, mediators, and other knowledgeable persons. If a formal hearing is required, the chair will appoint three members of the board to sit as a panel to hear the matter and to determine whether the practice in question is a “normal farm practice.” If it is not, the panel can order the farmer to stop or modify the practice.

The application of the legislation to salmon farming has been criticized by some local government representatives. Potential conflict between local zoning bylaws and resource use can be resolved through coastal land use planning, which is a primary recommendation of this report. Where local land use zoning rules are respected in a plan, the province would be in a weak policy position to exercise power under the legislation of concern to local governments. The EAO was not asked to consider this policy issue (the application of the Farm Practice Act to salmon farming) in the SAR, but encourages the province to undertake coastal planning that respects local land use rules.

The complaint procedures under the Act are new and as yet untested, but should provide an important new approach to resolving disputes that may arise in connection with operational practices at B.C. salmon farms.

Chapter 13. Policy Context and Advice

I. Strategic Objectives for Salmon Aquaculture

Individual agencies have operational-level policy and procedure statements and administer their programs under various regulatory tools that pertain to their specific mandates. The *Fisheries Act* provides that regulations may be made for “safe and orderly” aquaculture. This is evidence that provincial policy is to support aquaculture, as long as it is safe and orderly. Written development of this policy is limited, but it is implied that opportunities for salmon farming in B.C. will be provided, given the legislative and regulatory provisions for issuing approvals to farm salmon in B.C.

Clear, government-wide direction on the environmental, economic or social objectives that relate to the salmon farming industry does not exist. Provincial staff responsible for developing and implementing programs for managing salmon aquaculture in B.C. have been hampered by the lack of clear provincial corporate goals for this sector. This lack of a corporate view on the industry appears to have contributed to inter-agency disagreements over how the industry should be managed and potentially also to inefficient and inconsistent administration of the industry. Early in 1995, the Ministers of MAFF and MELP recognized the need for a broad corporate policy and agreed to an action plan to achieve that policy. Initial consultation on the approach identified the need to have certain technical issues reviewed.

Some broad guiding principles for managing industries based on natural resources do exist. They are documented in the provincial *Sustainable Environment Charter* and the *Provincial Land Use Charter*, and a set of draft provincial land use goals (including draft goals for the coastal zone) have been prepared which provide general policy direction on sustainability. There does not, however, exist a set of integrated provincial objectives that are specific to salmon aquaculture. These are urgently needed to guide the development of government policies and procedures for managing B.C.’s salmon aquaculture industry, and also to guide and support coastal zone planning exercises.

In developing this report, the EAO found it necessary to work within an undeveloped policy context for salmon aquaculture as a basis for developing and considering policy options and arriving at recommendations. The EAO also had to assume policy objectives (see Appendix 6) based on: the existing policy framework, reference to existing corporate policy statements of government,

research performed as part of the SAR public and interest group written submissions, and the discussions of the RC.

The newly established Fisheries Renewal program should be a consideration in this policy development. Also, the corporate approach should be to ensure that human health issues related to salmon farming activities are considered and accounted for, and that the appropriate agencies are directly involved for the broad policy development.

II. Policy Advisory Committee

The controversy that has surrounded salmon farming activity in B.C. can be attributed in part to the fact that growth and development of the industry have outpaced the ability of government to plan and manage it. Laws, regulations, policies and guidelines, although they have continued to improve, have regularly fallen short of expectations of a number of groups in society, including First Nations, local governments, and environmental, commercial fishing, recreational and tourism groups.

The need for direct participation of these groups in the salmon aquaculture policy-making process, as a means of clarifying expectations and interests, was recognized in 1986 by Commissioner David Gillespie when conducting the first provincial inquiry into the industry. He recommended the establishment of an “aquaculture advisory council” to provide a way for direct participation of the range of interests in policy development. The provincial government acted on that recommendation, and in 1987 formed the Minister’s Aquaculture Industry Advisory Council (MAIAC), comprising fifteen members representing aquaculture, commercial fishery, First Nations, recreational and environmental interests. That group stayed active until 1993 when it submitted its final recommendations to the Minister of Agriculture, Fisheries and Food to address salmon aquaculture policy issues.

An advisory group similar to MAIAC needs to be reconstituted to provide a constructive opportunity for the ongoing participation of key interests in the development and implementation of salmon aquaculture policy in B.C. The main purposes of the advisory group should be to:

- advise government on the coordinated and inter-disciplinary development and implementation of laws, regulations, policies, procedures and guidelines for salmon aquaculture in B.C.,**
- monitor progress in the implementation of policy reforms that flow from this Review through an annual report to Ministers,**
- advise government on priorities respecting research related to salmon aquaculture issues, and**
- serve as a forum for dialogue and information exchange among the range of groups with an interest in salmon aquaculture.**

As an initial task, the group might work with government agencies to advise on implementation of government's decisions in response to the SAR. Another priority task would be to work with the provincial government to develop a set of strategic policy objectives for salmon aquaculture in B.C. (see above recommendation).

The proposed advisory group should comprise representatives from all of the main sectors of interest. The sectors that were organized to participate in the SAR might form an appropriate model for structuring the group. The recently enacted *Fisheries Renewal Act* provided for a broadly based corporation to undertake programs to promote the protection, conservation and enhancement of fish stocks and habitat, and a range of other programs related to enhancing fisheries related activities and jobs. Since there are many aspects of salmon farming that are inter-related with or have the potential to impact wild fisheries, consideration could be given to utilizing the Fisheries Renewal Board or a related committee to provide broad policy advice to government on salmon farming. The board (or committee) has a legislative mandate to take into account First Nations interests. The salmon farming industry, as well as the other interests mentioned, should have representation on the organization. For purposes of aquaculture policy advice, the group should report to both the Minister of Environment, Lands and Parks and the Minister of Agriculture, Fisheries and Food, as the two Ministers with mandates that relate most directly to salmon aquaculture management. The advisory group should be encouraged to interact with representatives of all key agencies, (including the Ministry of Small Business, Tourism and Culture; Ministry of Health; Ministry of Aboriginal Affairs; Ministry of Employment and Investment; and relevant federal agencies) to ensure that the policy perspectives of these agencies are integrated into their discussions and advice that the group submits to the Ministers. These

Ministers should receive the advice of the group when it is relevant to their mandate.

Chapter 14. Implications of Recommendations

This chapter assesses the projected environmental, economic and social implications of the recommendations contained in this report. The assessment is primarily qualitative, although quantitative cost estimates are provided for some categories and are based on the assessment of the TAT recommendations (see Appendix 7).

I. Environmental Implications

A. General

Although the TAT concluded that B.C. salmon farming, as presently practiced and at current production levels, presents a low overall risk to the provincial environment, they identified concerns regarding negative localized environmental impacts such as effects on benthic organisms, potential tainting of nearby shellfish beds, and potential impacts on some local marine mammal populations. These findings, coupled with the fact that information gaps prevented the TAT from conducting fully comprehensive risk analyses, prompted the TAT to recommend numerous changes to the existing regulatory system. Their recommendations were directed primarily towards the increased prevention and mitigation of localized impacts, and also towards the reduction in risk of provincial level impacts, particularly on wild salmon stocks, given the degree of scientific uncertainty surrounding some of the issues. Thus, even though the TAT did not find evidence of significant or alarming environmental impacts or risks from salmon farming, they advocated a precautionary approach to regulating the industry.

The EAO endorses this perspective. Many of the recommendations contained in this report are aimed at providing further information to reduce uncertainty and preventing or mitigating the potential for negative environmental effects from salmon farming in the face of outstanding uncertainty. The EAO recommends adaptive environmental management as a strategy for managing this uncertainty and emphasizes that management strategies will need to change to be responsive. This means that the salmon aquaculture regulatory system should emphasize “learning by doing.” Management policies and practices should be adopted, based on best available information, and monitored to assess effects. Adaptations to those policies and practices should continue to be made on the basis of monitoring and research information.

The regulatory and policy changes recommended in this report are directed significantly toward establishing performance standards within which salmon farmers would be expected to operate. For example, the EAO recommends that salmon farmers should be subject to measurable waste discharge standards, as established in regulation. There are recommendations to require individual salmon aquaculture licences to contain comprehensive management plans that identify the specific measures that will be adopted at each salmon farm for fish escape prevention and recovery, fish health management and disease prevention, waste management, and predation prevention. It is proposed that these regulatory and contractual provisions would become the objective standards against which operators’ performance is evaluated, thus providing key tools for protecting

environmental quality, both at existing levels of fish production and at potentially expanded production levels.

Under the current management approach, operators are subject to very few objective and measurable (and thus easily enforceable) performance standards, and those that are in place (e.g., fish production limits) are not necessarily the best ones. With present arrangements, salmon farmers are not always clear on what is expected of them in terms of environmental protection, nor is there an effective legal means of enforcing environmental protection. The proposed shift toward a regulatory system that emphasizes clear, objective and enforceable performance standards is seen as a strong contribution to the prevention or reduction of potential environmental impacts from salmon farming.

B. Genetic and Ecological

The EAO recommends allowing Atlantic salmon culture to continue in B.C., even though many SAR participants suggested that farming be limited to Pacific species. The EAO perspective is based on the TAT's finding that Atlantic culture presents a low risk of hybridization with Pacific salmon species, and on the lack of evidence of detrimental competition by escaped farm fish with native species for habitat or feed. Evidence of reproductive colonization of Atlantic salmon in B.C. is also lacking, despite historic attempts to introduce the species, and even though a fairly large number of Atlantics have escaped into B.C. waters in recent years. Farming Pacific species is considered to pose a somewhat greater genetic and ecological risk, due primarily to the potential for interbreeding with native species and potential competition impacts. This risk, however, must be viewed within the context of salmonid enhancement efforts in B.C., where many millions of artificially reared Pacific salmon are released into the wild.

Earlier chapters of this report include recommendations that the provincial government:

- *locate farms (particularly farms with Pacific salmon) a prescribed distance from anadromous fish streams in order to reduce the possibility of escaped fish entering freshwater systems,*
- *require salmon farmers to include in their individual management plans, the specific measures that will be employed to prevent fish escapes,*
- *require salmon farmers to recover escaped salmon where an escape event exceeds a specified threshold number of fish,*
- *require salmon farmers to develop and maintain standardized inventory control systems as a means of tracking and reporting fish escapes,*
- *continue to prohibit marine rearing of transgenic (i.e., genetically engineered) salmon, which may have characteristics that allow them to "out-compete" native stocks,*
- *continue to implement the Atlantic Salmon Watch program as a means of monitoring the presence of Atlantic salmon in marine and freshwater systems,*
- *withhold approval of rearing facilities in freshwater lakes until a thorough evaluation confirms that there are no threats to indigenous fish species, and*
- *conduct research over the longer term into: further domestication of farm salmon to select for characteristics that reduce risks to native species in the event of escapes, development of all-female or non-*

reproductive Atlantic salmon, and chemical imprinting of salmon; so that escaped salmon are attracted to pre-defined locations.

These recommendations will all contribute to the prevention or mitigation of negative genetic and ecological threats from salmon farming in B.C. With a strong commitment to their implementation, the potential for hybridization, inter-breeding, colonization, predation and competition risks or impacts to native salmon stocks is estimated to be low.

C. Fish Health

The concern that salmon farming may lead to the importation of exotic fish diseases to which native stocks are not resistant, or to an increased incidence of transfer of indigenous fish diseases to wild stocks, has led to a number of existing regulations, policies and procedures aimed at preventing those possibilities. No exotic disease importation or increased incidence of disease transfer have yet been attributed to salmon farms in B.C., suggesting that the existing mechanisms may be effective in their aim. The TAT confirmed, however, that the potential consequence of such events, and the significant uncertainty surrounding these issues, suggest that there needs to be a high degree of vigilance and precaution taken in regulating the protection of fish health. Prevention of disease outbreaks and timely and effective response to disease outbreaks that may occur, from whatever source, should be the regulatory objectives.

The EAO has recommended a number of changes to the current regulatory system, including:

- *establishment of an interagency “Fish Health Working Committee” to cooperate in the development and management of policies respecting all aspects of fish health, including field investigations and surveillance, monitoring, assessment and reporting,*
- *application of common fish health standards and policies at all intensive fish culture operations, including commercial grow-out sites, commercial hatcheries and broodstock programs, and public and community enhancement hatcheries,*
- *adoption of active disease surveillance programs in the field, including the training of First Nations, and commercial and recreational fishers, to recognize and report disease in fish,*
- *naming the specific fish diseases that salmon farmers must report to the provincial Fish Health Veterinarian, as a means of ensuring increased awareness and responsiveness by authorities to fish disease outbreaks,*
- *interim requirements for operators to obtain a diagnosis from a recognized laboratory when fish mortality exceeds a specified threshold,*
- *expanded powers for fish inspectors to quarantine, seize and dispose of diseased farmed salmon,*
- *development and enforcement of fish health standards as a condition of all salmon aquaculture licences,*
- *cooperative development of linked fish health databases, and preparation of regular summary reports on the incidence of fish disease,*
- *strengthened policies and programs respecting fish egg importation, and transfer of fish within B.C., and*

- *tighter controls on drug use at farm sites.*

These measures should both ensure a proactive approach to disease prevention and establish the capability for safe and effective response to diseases that are detected, thus helping to protect the integrity of B.C.'s wild salmon stocks.

D. Waste Discharges

The EAO recommendation respecting benthic waste discharge impacts is to adopt measurable performance standards that will prevent degradation in sediments beneath, and in the vicinity of, salmon farming sites. Although some degree of enrichment impact can be expected with this approach, the aim is to ensure sufficient biological activity in sediments at all times so that they can be returned to ambient, or near ambient conditions groups, within short periods of time.

Due to a lack of historic monitoring of sediments at salmon farming sites, a specific performance standard cannot be recommended by EAO at this time, but a short process to set the standards and adopt them in an enforceable regulation should be implemented over the next 18 months. This will allow management agencies to confidently select the chemical or biological parameters and thresholds that are appropriate as the performance standard for prevention of benthic degradation. In the short term, farms would be expected to develop waste management plans or, whenever possible, adopt practices that will reduce impacts. Information on the extent of current benthic impact is equivocal. However, the total area occupied by salmon farms in B.C., and thus the area that is exposed to potential impact, is very small as a proportion of B.C.'s coastline.

Relative to existing arrangements, the recommendation to establish and enforce a waste discharge performance standard represents a significant improvement in the approach to addressing the potential for benthic impacts. Adoption of a measurable and enforceable waste discharge performance standard will replace the current, less direct method of waste impact management, based on the amount of feed used. The recommendations should provide an effective and efficient basis for ensuring that salmon farming activity does not lead to sediment degradation beneath farms.

Salmon farms have not been shown to have deleterious effects on the water column, and the recommendation that salmon farmers should be subject to the standard B.C. water quality objectives for nutrients and metals should ensure that salmon farming activities do not, in future, cause adverse water quality impacts.

E. Coastal Mammals and Other Species

Fish and wildlife (notably: marine mammals, birds, bottom dwelling fishes, and crustaceans) are attracted to salmon farms as a potential food source. Salmon farming activities impact on these creatures primarily through measures taken by salmon farmers to control predation at farm sites using various means, including physical protection methods, as well as through shooting predators and using noise-making devices. The TAT confirmed that these practices pose undesirable impacts and threats to native fish and wildlife, particularly marine mammals, and recommended a number of actions including:

- *requirement for salmon farmers to commit, in their individual management plans, to the specific physical measures that will be employed to prevent predation at the farm site (i.e., predation prevention plans),*

- *maintaining strict controls on the killing of predators at farm sites, including limiting shooting to situations where predators are inside farmers' nets and are actively attacking fish, or are about to do so, and requiring a standard of skill in the firearm user, and*
- *phasing out the use of ADDs over a two-year period to coincide with the adoption of predation prevention plans at each farm site.*

The TAT concluded that physical prevention is the preferred strategy for predation management at salmon farms, and this approach is recommended as the appropriate means to prevent or mitigate negative wildlife impacts from salmon farming. Adoption of these recommendations should result in a reduction in the current pattern of marine mammal killing at farm sites (averaging at over 500 animals per year in B.C.), but the numbers must be monitored to provide exact figures. The recommendations to discontinue the use of ADDs should reduce the potential for hearing damage in marine mammals, and may allow any pinnipeds and cetaceans which were avoiding the deterrent, to re-establish their natural range of movement. These benefits will not be fully realized for two years, as that is the time period proposed to allow salmon farmers time to adjust to these recommendations.

The recommendation not to allow any more salmon farms to use night lighting, pending research into the effects of this practice on local biota, is essentially a strategy for addressing uncertainty that continues to surround this issue. There is presently no scientific evidence to suggest that this practice results in negative environmental impacts, however, observational evidence suggests otherwise. Limiting this practice to the operators that presently engage in it will ensure that impacts, if there are any, remain limited, pending the results of further research. As discussed in Chapter 10, ongoing monitoring and evaluation are required to determine more exactly the environmental effects of the recommendations, and their benefits and costs. Adjustments to management should be made as required when better information becomes available.

II. Economic Implications

The environmental impact and risk reduction strategies that are embodied in these recommendations imply a cost to government and the salmon farming industry. These cost implications have been considered in formulating recommendations, consistent with the requirements described in section 2 of the EAA, and in light of provincial sustainability principles, which emphasize the inter-relation of environmental, economic and social objectives. The following sections describe the economic implications of these recommendations to both government and industry sectors.

A. Costs to Government

Costs to the provincial government over the next three years of implementing the recommendations contained in this report are expected to be in the range of \$2 million to \$4 million annually. These costs may be reduced if measures are adopted to recover administrative and regulatory costs from the salmon farming industry. The areas of greatest anticipated cost impact to the province are:

- *fish health disease surveillance measures and related fish health data management and auditing,*
- development and enforcement of performance standards, and
- *research initiatives.*

Additional expenses that government may include are the costs of identifying sites requiring remediation and the costs of working with existing operators to amend husbandry practices, or to relocate to a different site. Assessing the impacts of antibiotics in feed on seafood resources is another component of the anticipated costs.

Several mechanisms to cost recover or cost save on the administrative, and other costs to government for the management of the industry exist now, or are recommended.

They include:

- annual fees charged for the use of the Crown land tenure,
- proponent developed tenure application and supporting inventory data,
- proponent-sponsored open houses as a means of providing public notice of a pending application,
- industry-supported research,
- cost recovery of disease control on a case by case basis,
- annual registration fees for farms with MELP, Environmental Protection Division,
- fees for discharge of wastes based on contaminants, and
- *costs of site reclamation through a bond.*

While most areas of management have a cost recovery mechanism, it is important that the fees are reviewed from time to time.

Recognizing that government's staff and financial resources are limited, several implementation priorities are recommended in Chapter 15. Other recommendations in this report should proceed as time and resources permit.

A number of the EAO recommendations pertain to the federal government's role in the management of salmon aquaculture and marine resources, and there will be costs to federal agencies. For example, the recommendations to: establish an inter-agency Fish Health Working Committee, improve fish health protocols and diagnostics, cooperate in a fish health database, establish escape recovery plans, improve the inventories and classifications of anadromous fish streams, and undertake multi-party coastal zone planning; all have cost implications for federal agencies. Since the federal government has reduced its research capability, costs of research will have to be shifted to a sharing by agencies and industry through independent researchers.

As suggested in Chapter 15, a federal / provincial strategy will be necessary to implement many of the recommendations, and a review of existing federal / provincial protocols will be needed. The recommendations pertaining to decision-making will have costs to local governments and First Nations. These costs may be offset by less effort being directed to conflict resolution and more to conflict avoidance; due to better decisions pertaining to siting and the availability of a provincial process to deal with operational complaints (*Farm Practices Protection (Right to Farm) Act*).

B. Benefits to the Province

It is important to appreciate that, aside from the environmental advantages described in the previous section, economic benefits are also expected to flow from the proposed reforms to the salmon aquaculture regulatory system. The recommendations are aimed at ensuring the sustainable future of salmon aquaculture in B.C.,

primarily through the prevention of impacts on, and costs to, other resources and sectors. In this sense, provincial, federal, local government and First Nations costs to implement the recommendations may be seen as investments into impact and risk reduction, thus encouraging provincial economic development and diversification. A sustainable salmon farming industry that does not negatively impact and conflict with other sectors will produce long-term, direct and indirect, net taxes and fees to government, and will also provide the economic and social benefits of secure employment. This can be achieved in a certain policy environment. Much of the industry's employment is centered in rural communities that are now experiencing difficult transitions as a result of changes in the traditional commercial fishing, forestry and mining sectors. Regulatory investments to ensure sustainable salmon aquaculture may contribute to cost-savings in employment insurance and social assistance payments.

With current approaches and levels of production, the industry directly and indirectly generates over 2,200 person years of employment (the latest estimate is 2,500). While this is perhaps not substantial from a provincial perspective, the jobs are very significant to the individuals who hold them; and also to the communities that receive the stabilizing benefits of steady employment and income. Government currently receives about \$4 million in taxes and fees annually from the industry, which is roughly equivalent to the costs to government of adopting the recommendations contained in this report, but not enough to also cover the present levels of indirect financial support to the industry and existing levels of regulatory effort. Should the industry experience some future expansion on account of recommendations to promote a sustainable future for the industry, tax, fee and employment benefits can be expected to increase proportionately. In addition, depending on government-wide policies respecting administrative and regulatory cost recovery (i.e., "user pay" principle), government revenues from salmon farming may further increase in the future.

C. Costs and Benefits to the Salmon Farming Industry

The recommendations arising from this review, although focused on government's management of the industry, if implemented, will have significant impacts on the industry. Impacts of the recommendations on the salmon farming industry are difficult to assess; nonetheless, estimates for some of the recommendations have been developed and are presented below.

1. Siting Criteria

Recommendations respecting salmon farm siting criteria (see Chapter 4, Table 13) are important to industry, given the potential impact on the availability of marine sites at which to locate salmon farms. Recognizing this importance, the EAO conducted an analysis of the proposed siting criteria to estimate effects on potential site availability. For this purpose, available resource inventory information was used to model the siting criteria on the west coast of Vancouver Island and in the Broughton study area. The analysis, which it is important to note, provides only an approximate, regional-level indication of siting criteria effects,¹ suggests the following conclusions, as demonstrated in Table 19:

1 Analysis of the effects of recommended siting criteria was conducted by LUCO, Resource Analysis and GIS Unit, using available federal and provincial information sources stored in the CIIS. The siting criteria were modelled for the two geographic areas using GIS technology. Local and site-specific information on biophysical characteristics that may be important for farm site decision-making (e.g., water currents, water temperature, oxygenation, etc.) were not available and were not modelled, although MAFF's biophysical capability information that was used to determine "net residual area" takes some of those parameters into account. Information on First Nations traditional use was not incorporated into the model and this factor would likely further constrain available resources.

- A relatively limited proportion of coastline possesses the basic biophysical capability to support salmon aquaculture. This is referred to as the “base area” in Table 19. (The “base area” is about 9 per cent on Vancouver Island’s west coast; 11 per cent in the Broughton.)
- *Application of the recommended siting criteria substantially reduces the proportion of “base area” that would be available for salmon farming. The residual area, when considered in relation to MAFF’s salmon farming capability information, results in approximately 7 per cent of the “base area” on the west coast of Vancouver Island, and about 18 per cent of the “base area” in the Broughton, as available for salmon farming activity.*
- *Although these figures are relatively modest as a proportion of the “base area,” and are even more modest as a proportion of the marine coastline (i.e., 1 per cent on west coast of Vancouver Island, and 2 per cent in Broughton), they still represent sizeable opportunities for salmon aquaculture (over 6,200 ha on west coast of Vancouver Island, and about 3,500 ha in Broughton), considering that all of the existing salmon farms in B.C. occupy less than 200 ha of marine area in total.*

Thus, the overall estimated effect of the proposed siting criteria is that environmental impacts and user conflicts will be prevented or reduced, allowing for efficient operations at salmon farms. Some suitable coastal areas in B.C. will remain available for salmon farming, even though the availability of areas is substantially reduced by application of the siting criteria.

Table 19. Approximate Effect of Recommended Siting Criteria

	West Coast Vancouver Island			Broughton Archipelago		
	Area (ha)	% of Study Area	% of Base Area	Area (ha)	% of Study Area	% of Base Area
Marine Area	524,391	100		175,538	100	
Base Area	45,705	8.7	100	19,363	11.0	100
Siting Criteria	37,268	7.1	81.6	12,797	7.3	66.1
Residual Area	8,437	1.6	18.4	6,566	3.7	33.9
Net Residual Area	6,115	1.2	13.4	3,955	2.3	20.4

Marine Area—Marine surface area within area of study (see Map 1 for Broughton Study area, which includes a variety of water depths. West Coast Vancouver Island Study area covered water area up to 60 metres deep, with any type of wave exposure, from Cape Scott at the northern end of Vancouver Island to Cape Beale at the southern end of Barkley Sound).

Base Area—Marine area with basic biophysical capability for salmon farming, based on depth (30 - 60 metres) and wave exposure (low to medium) criteria.

Siting Criteria—Base area that is not available to salmon farming due to application of recommended siting criteria.

Residual Area—Base area that is available to salmon farming following reduction of area affected by Siting Criteria.

Net Residual Area—Residual area that overlaps with areas rated by MAFF as having either “high” or “moderate” capability for salmon aquaculture.

These conclusions must be considered in light of a number of other factors.

First, the overall effect of the proposed siting criteria is apt to not be very different from the effect of the existing siting guidelines. This is because although some of the proposed siting criteria are new and/or more constraining (e.g., increased distance separation from shellfish beds, new criterion to separate salmon farms from important herring spawning areas, disallowance of farms at important recreation / tourism sites), other proposed criteria are relaxed relative to the existing siting guidelines (e.g., the existing three kilometre spacing restriction is replaced).

Second, the recommendation to develop integrated coastal zone plans may result in the designation of specific coastal areas for salmon aquaculture, which may have been constrained from availability, if the recommended siting criteria were applied as part of the individual site application process (i.e., the integrated planning process may result in resource trade-offs in some locations in favour of salmon aquaculture). As well, the suggestion that government may wish to lift the existing moratorium in a staged manner, in association with government efforts to pre-clear and market suitable sites (i.e., application of an “interim process” — see chapter 15), may mean that some sites may become available that would not have otherwise.

Third, the proposed siting criteria are based on the state of existing salmon farming technology. If farming systems are adopted that allow locating farms in deeper, more exposed waters, or if systems are used that further prevent or mitigate near-shore impacts and conflicts (e.g., closed containment systems), then additional siting opportunities may be expected.

2. Evaluation of Existing Sites

The recommendation to evaluate existing salmon farms, with a view towards remediation of local environmental impacts and conflicts, stems primarily from concerns that some existing operations are causing undesirable benthic effects or negative effects on nearby seafood resources, especially shellfish. There may also be other effects on First Nations interests that were not assessed at the time of the original tenure issuance that now need to be reviewed.

Definitive information on the number of farms that are causing significant benthic effects is not available, although the TAT’s rough estimate is that one-fifth of existing farms may be causing undesirable benthic impacts. The most likely approach to remediation of benthic problems would be post-harvest site fallowing and production decreases for the following production cycle. Both of these measures would present operational costs in proportion to the fallowing period and the size of production decrease. If production was reduced to non-economic levels, then the remediation strategy might be to relocate to a site with a greater inherent capacity to assimilate and disperse wastes. The estimated cost of moving a site ranges from \$10,000 (minimum towing costs) to over \$100,000 if extensive new anchoring systems are needed. Other potential costs include the need for different types of cages and equipment, and additional operating costs related to a new site, such as increased staff commuting costs and reduced productivity, at least in the short term. If the tenure holder is expected to locate a new site, that tenure holder would bear the costs of site approval.

With respect to existing farms that are potentially causing undesirable impacts on shellfish beds, or other interference with aboriginal interests, a review of existing salmon farms on Vancouver Island’s west coast suggests that 15 of 32 farms are located at sites that may be in some conflict with fisheries, shellfish, sensitive habitat, or important recreation / tourism resource interests. While it must be stressed that this does not necessarily mean that these farms will be expected to relocate, it does indicate that some relocation costs may be anticipated (at a mean per farm cost of approximately \$50,000) to remediate the undesirable effects of inappropriate former siting decisions. Where relocation is required, given that the province approved the site originally, government could expect to incur costs in relocation, and inevitably, industry will also bear some costs. Where existing

farmers hold approved licences that are in good standing, and where government recommends relocation, these costs should be government's responsibility (see Recommendation 8).

Although there are potential short-term cost implications associated with the remediation of problems at existing sites, longer-term benefits to operators may also be expected, given that proper siting is a key to the reduction of impacts and conflicts from both the government's and the farmer's point of view. Potential benefits include more efficient and continuous production of healthy farmed salmon.

3. Escape Prevention and Mitigation

The recommendations to require salmon farmers to develop and implement escape prevention plans, to recapture fish where escape events exceed a certain level, and to adopt standardized inventory control systems for tracking escapes, are generally consistent with the industry's own objectives to prevent economic losses from fish escapes. Nonetheless, new costs to industry are inherent in these requirements. At some sites, the new requirements might mean the need for: more secure anchoring systems, protection of net-cages from wave exposure, use of propeller guards on work boats, adoption of different fish handling / sorting methods, or installation of predator nets. There will also be costs associated with putting escape recovery plans and equipment into place.

Industry may be expected to invest in these strategies if it is cost-effective to do so in relation to the risk of economic losses from escapes. This suggests that, despite industry's self-interested motive to prevent escapes, the recommended requirements to strengthen escape prevention and mitigation measures will result in some incremental costs to farming operations relative to the existing situation.

4. Fish Health

As with fish escapes, the salmon farming industry is already motivated to prevent costly fish disease at their sites. This motivation may in fact be very strong, given the potentially significant financial impact of a serious disease outbreak at a farm. Therefore, the recommendation that farmers be subject to enforceable fish health standards, including standards on disease prevention and management protocols, minimum health record requirements, outbreak management protocols, drug use, and disease reporting, are unlikely to cause significant incremental costs to the industry, relative to existing costs.

However, with the proposed standards, there is an added level of assurance to individual farmers and the industry as a whole that all is being done that can be done at farm sites to protect investments and the industry's reputation.

5. Waste Discharge

Costs to the industry of the recommendation to adopt a benthic performance standard for waste discharges at salmon farms cannot be estimated at this time. This monitoring requirement in the process to establish the standards may itself pose a one-time cost to existing operators in the range of approximately \$5,000 to \$10,000 per farm. Additionally, there will be an annual fee for the registration of each farm with MELP, and waste discharge fees for contaminants.

Of potentially greater significance to salmon farmers is the principle being advocated that salmon farming should not result in degradation of the sediments and that impacts should be localized within the tenure. This represents a shift away from the current approach where benthic conditions may in fact be unknown. The recommendation further suggests following the site to enable sediments to regain their bio-assimilative capacity before a new production cycle is begun. The implication of the proposed approach is that production levels at individual farms

may be reduced compared to existing or proposed levels, and this may affect economies of scale at the individual farm level. It may also mean that a somewhat greater number of sites is needed by firms to grow the same number of fish, and this may affect economies of scale at a company level. It may also mean that sites require shorter fallow periods. The financial consequences of these recommendations may be significant to individual farms or companies.

6. Coastal Mammals and Other Species

The recommendation that salmon farmers should emphasize physical means of predator prevention, and that the use of ADDs be phased out, is expected to have cost impacts at some salmon farms. At present, about one-third of existing salmon farmers do not employ predator net systems, and there may be a requirement for some of these operators to adopt this practice, depending on the extent of the predation threat. A predator net system for a 24 net-cage operation costs about \$250,000. It is not known if the specific companies that do not use predator nets rely instead on the use of ADDs for predation control. Eighteen farm sites presently use ADDs.

Depending on government's response, operators who bought ADDs upon government's recommendation (at between \$5,000 and \$20,000 per unit), may receive some compensation for the discontinuance of their ADDs.

Assuming that the recommended measures for predation control are effective, operators may expect benefits from reduced financial losses from escapes, mortality, injury and stress in their stock. The recommendation to closely monitor the effectiveness of the proposed predation management approaches should enable farmers and regulatory agencies to soon determine if there is any increased incidence in shooting of seals and sea lions. The monitoring costs would add approximately \$50,000 per year per farm. It is suggested that additional shooting would present a significant "image problem" for the industry.

The recommendation to limit approvals for night lighting to farms presently approved for this practice, pending further research, will cause no impact to those approved farms. There may be opportunity costs to farmers who want to adopt this practice, but are prevented from doing so, at least in the short term. If, following the recommended research, night lighting is prohibited at all farms, this could have a negative impact on the competitiveness of the B.C. industry.

7. Research

While costs of the high priority research items for government summarized in Chapter 10, Table 17 are discussed above, industry currently actively supports cost shared initiatives with government, universities and other research organizations. Government will continue to expect financial support from industry for these purposes, as outlined in Recommendations 40 and 44.

D. The Marine Tourism Sector

One of the more important potential conflicts with salmon farming from a socio-economic perspective is the conflict with marine tourism. Based on a SAR survey of marine tourism operators in the Broughton Archipelago, and on other studies,² the marine tourism industry can rival the employment contribution of salmon farming in certain regions. Marine tourism is also one of the fastest-growing sectors of the economy, also verified by the Broughton survey.

Recommendations governing the siting of salmon farms have the most significant implications for tourism / salmon farm conflicts. Recommendations regarding the phasing out of ADDs and waste discharge standards are expected to reduce the conflict. Other management issues such as visual design and predation control can affect the quality of the tourism experience and therefore its commercial value, but are less important.

The Broughton tourism survey suggests that the major concern of operators who depend on a pristine environment, such as kayaking and whale-watching operators, is the number of salmon farming sites. Some of these operators may be able to relocate to other coastal locations (e.g., mid coast) if the number of salmon farms in their existing operating areas increases appreciably. However, this would likely result in a dislocation of existing regional tourism employment and investment, and would not be practical in the case of operations that rely on an existing tourism presence, such as in Clayoquot Sound. In the longer term, sizeable growth in the coastwide number of salmon farms may result in forgone opportunities and some losses in the marine wilderness tourism sector.

The recommendation to recognize recreation / tourism sites and protected areas when making siting decisions should mitigate, but not eliminate, the impact of salmon farming on this segment of the industry. The development of coastal zone management plans is critical to the co-development of salmon farming and the wilderness-dependent component of the marine tourism sector. It will benefit both industries if areas can be defined where each industry will be individually encouraged or protected.

ADDs may alter movement patterns of whales and other marine mammals such as harbour porpoises, which are an important resource to marine tourism operators. There seems to be some evidence that whales do not appear as frequently as they once did in the Broughton. Whether this variation in movement patterns is a natural phenomenon, or is attributable to the use of ADDs at salmon farms or the availability of food sources, is not conclusively known. The recommendation to discontinue the use of ADDs may provide a benefit to the marine tourism sector.

Enforceable waste discharge standards, particularly in conjunction with proposed siting recommendations, may lead to a trend for farms to move out of sheltered bays into more exposed sites, where deeper waters and stronger current flows more effectively dissipate waste discharges, and where resource user conflicts are fewer. This would free up more of these sheltered bays for anchorages and camping spots, thus allowing for a potential increase in tourism activities.

2 For example, "Socio-Economic Impact Assessment: Clayoquot Sound Scenic Corridors Landscape Management Plan" April, 1995.

III. SOCIAL IMPLICATIONS

The social implications of this report's recommendations relate most directly to the individuals and communities that are in closest proximity to salmon farming operations, particularly coastal residents and communities which supply employment for salmon farming grow-out, fish processing and support services; as well as First Nation groups. The recommendations, however, also have a bearing on the larger social fabric of B.C., in the sense that, many of the recommendations are designed to ensure the continued integrity of wild salmon stocks, upon which many individuals and communities throughout B.C. are significantly dependent. To a lesser degree, the recommendations also relate to other social interests, including those of marine outdoor recreationists.

A. Coastal Residents and Communities

The reforms proposed in this report should benefit coastal residents and communities in several ways. First, increased community access to salmon aquaculture siting and management decisions, through direct participation in proposed coastal zone planning processes and local advisory working groups, will help ensure that local priorities, preferences and local knowledge respecting coastal resources are incorporated into management decisions. The recommended requirement that salmon farm siting decisions continue to conform with local government land use by-laws will also ensure that local interests are reflected in decision-making.

Second, the recommendations aimed at increased transparency and openness of salmon farming activities (e.g., on-line access to: information on the status of tenuring and licensing decisions, public reporting of fish escapes, disease incidence, and pesticide use at farms) will help keep coastal residents and communities informed about industry operations. The SAR heard many concerns about the lack of access to reliable information on the status and activities of the industry.

Third, the proposed reforms are all intended to ensure a sustainable salmon aquaculture industry—one that provides stable direct and indirect employment in coastal communities, and which does not endanger opportunities in other coastal sectors, such as the traditional commercial fishery or marine tourism.

B. First Nations

The SAR determined that, to date, B.C. First Nations have received very few, if any, benefits from salmon aquaculture, yet as a group have been subjected to the greatest proportion of impact from the industry. This may contribute to First Nations general opposition to salmon farming in their traditional territories.

A number of reforms are proposed in efforts to address this issue, including:

- *continued government assistance in mapping First Nations traditional coastal resource uses as a basis for assessing interactions between First Nations interests and rights and salmon farming proposals,*
- *direct participation by First Nations representatives in coastal land use planning processes, as a means of ensuring that First Nations information and preferences are incorporated into strategic land use decisions (land use planning decisions are without prejudice to First Nations treaty negotiations),*
- *negotiation of local consultation agreements between the provincial government and individual First Nations groups, modelled after existing agreements, that describe roles and responsibilities in salmon farm siting decision-making,*

- *membership of First Nations on the Fish Farm Review Committee(s),*
- *First Nations representation on the proposed provincial level “Salmon Aquaculture Advisory Group,” as a means of ensuring a First Nations voice in salmon aquaculture policy level discussions,*
- *focused and timely research into the specific concern of First Nations about the potential effects on human health of antibiotic drug use at salmon farms,*
- *an increased First Nations role in resource management through monitoring of operational activities at salmon farms, and*
- *encouragement of First Nations - industry joint ventures and participation agreements, to secure greater economic and social benefits to First Nations.*

Existing and future pre-treaty interim agreements and ultimately treaty negotiations themselves will determine the final role of First Nations in coastal resources management in B.C.

C. Marine Outdoor Recreation

Salmon farming and marine recreation activities, such as: boating, kayaking, camping, and scuba diving, can come into conflict unless relationships between the uses are properly managed. The recommendations attempt to address issues of potential conflict in several ways:

- *coastal zone management planning is encouraged as a means of identifying geographic areas where recreation activities will be assigned management priority, thus ensuring continued opportunities for wilderness-oriented marine experiences,*
- *the recommendation for continued improvement of natural resources inventories and mapping, including recreation and tourism resource inventories, will ensure that coastal land use planning as well as individual salmon farm siting decisions are made with appropriate information,*
- *revised siting criteria will ensure that salmon farms are not located at important recreation / tourism sites, do not conflict with marine anchorages, and do not prevent public access to the shoreline, and*
- *the proposed aquaculture code of practices can be expected to incorporate visual design guidelines as a way to minimize scenic impacts of salmon farms on recreationists.*

As well, given that marine recreationists are largely attracted by B.C.’s environmental qualities, this report’s recommendations aimed at protecting environmental conditions and fish and wildlife resources from the negative impacts of salmon farming, should help contribute to the overall maintenance of high quality marine recreation experiences.

CHAPTER 15. IMPLEMENTATION

This report provides the Minister of Environment, Lands and Parks and the Minister of Agriculture, Fisheries and Food with the results of the examinations by the EAO under the EAA into government's approval processes and mitigation methods in use under enactments for salmon aquaculture. These Ministers may issue guidelines for the administration of the approval processes and mitigation methods. This report concludes that, at times, guidelines to the enactments may not be adequate, and that legislative and regulatory changes are necessary to support the recommendations. Recommendations regarding the needed legislative, regulatory and policy changes are summarized below.

Implementation of these proposals now becomes the responsibility of the managing agencies, and the EAO's task was as outlined above. However, this report has inevitably commented on timing and degree of importance of certain recommendations which may provide assistance to these agencies in their task ahead. Appendix 8 proposes a time frame for the implementation of many operational recommendations, and Table 17 proposes a time frame for undertaking research. It is recognized that the capacity of managing agencies to implement substantial change over a short period of time is limited. Clear priority-setting by agencies in implementing change will serve the agencies, industry and the public well.

I. Recommended Change to Approval Processes: Legislation, Regulation and Policy

The need for a broad provincial policy framework for salmon aquaculture is discussed in Chapter 13. Its development is critical for government to move forward with implementing change, and to provide industry and the public with a clear understanding of the direction government is taking. It is essential that the policy be developed and documented as quickly as is practical. This report is recommending that many of the operational practices related to salmon farming be managed through the establishment and delivery of performance-based standards. A conceptual framework for the management framework is provided in Figure 14. A summary of the recommendations for a new legislative and policy framework is provided in Recommendation 49.

A. Legislation

Once the Ministers of Environment, Lands and Parks and Agriculture, Fisheries and Food complete the policy development referred to above, the province should consider enactment of legislation that expresses the policy directions of the province. A broader legislative base for the management of the industry, whether as stand-alone legislation or as part of the *Fisheries Act* (B.C.), would allow a shift from the current narrow management objective to ensure "safe and orderly" development of the industry, to an approach that provides industry stability and sustainability through the protection of the environment, while fostering a sound economy and social well-being in B.C.'s coastal communities.

Figure 14. Components of Management Framework for Salmon Aquaculture in British Columbia

Since it is recommended that the salmon aquaculture advisory group be re-established to have a role in consultation on policy development, the group could also serve as a consultative body for legislative proposals. Changes to the *Land Act* and *Waste Management Act* are not necessary to implement the recommendations.

The *Animal Disease Control Act* should be made applicable to fish disease immediately, since it requires the reporting of fish diseases and provides for the prevention and spread of disease through various mechanisms, including isolation and quarantine. The Fish Health Working Committee, when operational, and when fish diseases have been made reportable, should review the legislation, and if necessary, make recommendations for changes to ensure there is adequate capacity to support all functions related to effecting disease control measures in the aquatic environment and to ensure government costs of disease control can be recovered if necessary (see Chapter 6, recommendation 16). Until the legislation is made applicable to fish disease, new and renewed fish farm licences could require the reporting of fish disease and a number of the disease management provisions of the legislation terms and conditions.

As coastal zone planning proceeds in the province, planning policies and procedures may become more systematized. The province should consider whether or not to create a legislative framework for this function, if consistency of plan development and implementation becomes a policy goal.

B. Industry Code of Practice

Throughout this report, mention is made of the need for the development of a Code of Practice (code). Since this need was previously identified by earlier reviews, its development has already been initiated by MAFF and industry.

The code would explain best operational practices for the salmon farming industry and contain the overall requirements for industry. The code would:

- *cover all of the requirements for, applying for, and operating a salmon farm and related operations in B.C., including a central summary of the legislation, regulations, and policy and their requirements,*
- *provide guidance about optimum husbandry practices and procedures to maintain the best salmon farming practices, and*
- *set out monitoring requirements and protocols.*

It would also:

- *describe the processes for applying for tenure, operating licences and other necessary authorizations or approvals, and*
- *outline methods for addressing complaints and resolving disputes.*

Particular practices described in the code could be made enforceable by reference to them in regulation (Aquaculture Regulation, Aquaculture Waste Control Regulation and new performance standards waste management regulation, Animal Disease Control Regulation). If a provision of the code is not generally applicable to all farms, it could be referenced by the aquaculture licence to make the provision specific to a particular farm.

The development of the code must be given high priority in order to establish the basis for performance-based management of salmon farms. Unless the codes are in place to provide the objective basis for monitoring and enforcement, a performance-based approach cannot be adopted. Also, the code can be used as an objective standard that describes methods of practice in order to deal with operational complaints and formal farm practices complaints. Developing and adopting the code will ensure common, high operating standards, and encourage positive relationships between the many interested agencies and interests. The code will require ongoing support to ensure the contents are updated to reflect changes to manage adaptively.

C. Regulations

1. Aquaculture Regulation

The *Aquaculture Regulation [Fisheries Act (B.C.)]* should be amended to establish requirements for:

- *submission of standardized information in the licence application, including information to determine that the proposed salmon farm will be able to meet the requirements of the new waste management regulation,*
- *methods for fish containment and prevention of escapes,*
- *fish inventory requirements,*
- *methods to respond to escapes,*
- *fish health management,*
- *predator prevention plans, including a prohibition against the use of acoustic deterrence, and*
- *monitoring and enforcement.*

The *Aquaculture Regulation* would contain requirements that are referred to in the code, and become enforceable standards, applying to all salmon farms in B.C.

2. Aquaculture Waste Control Regulation

Changes to the *Aquaculture Waste Control Regulation (Waste Management Act)*, before the new waste management regulation is enacted, could eliminate the requirement for permits, and shift all producers to managing under an approved waste management plan. This amendment could be made immediately as an interim step to the development of the new waste management regulation.

A new waste management regulation is required, as recommended in Chapter 7, to provide a performance based approach to the management of waste. Over the next year, a relatively intensive program of monitoring several key sediment and certain water quality parameters at salmon farms is needed. The results should be correlated to biodiversity impacts beneath salmon farms as a means for defining and implementing waste discharge performance standard(s) for salmon aquaculture in B.C. The need for a new approach to farm waste management has been recognized by MELP since 1994, but work to address this need has been delayed pending the outcome of this review. The approach recommended in this report is one step closer to implementing the MELP direction towards pollution prevention for salmon farms.

3. Animal Disease Control Regulation

The Animal Disease Control Regulation (*Animal Disease Control Act*) may also, in future, require amendment, once the Fish Health Working Committee has an opportunity to work with its new mandate. If amendments are made, they should provide for and recognize the roles of the existing Fish Transplant Committee and the Fish Health Working Committee.

D. Land Act Tenure Document

The *Land Act* tenure document (licence or lease) will continue to provide the threshold approval for a salmon farm. The tenure development plan should allow for flexibility for operational change (moving of equipment, etc.) consistent with the code, as farmers will be required to meet high operational standards and at times, make changes at the site to infrastructure.

E. Licences

1. Aquaculture Licence

After amendment of the Aquaculture Regulation, all standard and farm-specific operating requirements will become enforceable terms and conditions of the aquaculture licence. Specificity can be needed for a number of biophysical reasons, such as to address species farmed and production targets. The aquaculture licence may also refer to operational practices provided in the code and adopt these as terms and conditions.

Until regulatory and code changes are made, the licence (new or renewed) can be used to prescribe the operational standards described above for the code and Aquaculture Regulation, including:

- *the fish containment technology and fish inventory system,*
- *husbandry practices that will ensure chronic loss and escapement are avoided,*
- *a recovery plan, should an escape event beyond the number set in the licence occurs,*
- *disease prevention and fish health management plans, emphasizing husbandry practices that will prevent fish disease,*
- *the procedure to be followed when notice of drug use at the farm is required,*
- *the predation prevention plan, and process to ensure staff meet skills and educational standards with respect to firearm use,*
- *site design to avoid visual impacts, and*
- *husbandry practices to minimize noise.*

This will require a significant amount of work for an individual licence, but is a means of bringing new farms immediately under the new operational requirements, and could be used to upgrade existing licences. Licences should be issued on an annual basis for three consecutive years. If the licence holder has been operating in compliance with the terms and conditions of the licence for each of those years, the term of the licence for the fourth year of operation should be extended to three years. If during a three year term a compliance problem arises, the term of the licence should return to annual for another three years.

2. Medicated Feed Dispenser / Vendor Licence

Licences to manufacture and dispense medicated feed are issued under the *Pharmacists, Pharmacy Operations and Drug Scheduling Act (B.C.)*, Part 8 (Medicated Feeds and Veterinary Drugs). Currently, oxytetracycline-medicated feed can be sold without a prescription. However, no medicated feed for salmon farming has been sold by a medicated feed licensee without a veterinarian's prescription since 1995. A policy should be formalized as a term and condition of the medicated feed dispenser / vendor licence providing that sales of medicated feed for the purpose of salmon farming should be allowed only under a veterinarian's prescription, except for urgent situations where the delay due to obtaining the veterinarian's prescription would create a serious risk of disease outbreak.

F. Policies, Guidelines and Agreements

Administrative policies and guidelines will be needed to operationalize many of the recommendations of this report, including the changes discussed above. Additionally, policies should be adopted to implement the recommended approval processes.

Much has been said about the need for consistent and effective enforcement of the regulatory framework of the salmon farming industry. Specific enforcement mechanisms were often suggested during the review as means to ensure compliance. Operational enforcement and compliance policies exist in the ministries, but are not centrally documented. The policies of MELP and MAFF regarding enforcing legislation, regulations and licences should be

upgraded to serve the new regulatory framework, and be compiled in one document. It will provide clear guidance for fair and consistent treatment of all salmon farmers and provide information to the public who are concerned that laws must be enforced. A compliance and enforcement policy will encourage preventative aspects of the recommended legislative and regulatory regime and promote compliance. It will also outline the range of punitive actions available to the agencies and describe when each action should be used to promote compliance and to deter violations as a means of achieving the goals of the management framework.

The power to issue tenures on provincial Crown land for aquaculture should remain under the *Land Act* to ensure similar policy treatment of salmon farming tenures with other Crown land tenures. Policy guidelines should be adopted to formalize the proposed tenure review process outlined in Figure 11. The policy should adopt the proposed approach to siting, including the siting standards, for making siting decisions. The term for the tenures should remain at 10 years for a licence and 30 years for a lease.

Provincially, policy guidelines should be developed to adopt the licence approval process outlined in Figure 15, regarding the issuance of the salmon aquaculture operating licence and waste management plan approvals. Another priority is the establishment of the Fish Health Working Committee.

New policy arrangements will be needed with the federal government to secure its cooperation and support in implementing many of the recommendations. The group of relevant interagency protocols will require review, but many recommendations can be implemented through changes to the Canada / British Columbia Memorandums of Understanding pertaining to aquaculture development and the FTC.

Amendments to the aquaculture development MOU would:

- *establish cooperation in the function of the Fish Health Working Committee,*
- *clarify mechanisms and approaches to developing and maintaining a common fish health database (the 1995 MOU between DFO and MELP regarding a fish health database will require review and possible amendment as a result of changes to the aquaculture MOU),*
- *describe an approach to approving escape recovery plans on a regional basis, and*
- *describe an approach to the phase out of ADDs.*

Agencies may determine other items for addition to the MOUs.

**Figure 15. Proposed Salmon Aquaculture Review Process—Licence
[Fisheries Act (BC)]**

Amendments to the FTC MOU should describe an approach to imposing and delivering further limitations on the number and purpose (for broodstock only) of importations of salmon eggs and continue the current policy prohibiting the importation of live fish, unfertilized eggs and milt.

Recommendation 21 in Chapter 6, suggests cooperation between the Canadian Food Inspection Agency, DFO and the province (led by MOH), to review sampling protocols in the processing plants, the results of which may require changes to existing operating agreements. Recommendation 23 in Chapter 6, raises the need for cooperation between the provincial MOH, MELP and MAFF and the federal health agencies. Certain issues raised about the use of drugs and human health concerns fall entirely within the mandate of health agencies, especially at the federal level, and were outside the terms of reference for this review. However, discussions are necessary amongst these agencies to determine whether or not to pursue these issues and the mechanisms for that consideration.

G. Conclusion

In addition to guidelines to enactments for the key approval process, some legislative and regulatory change, as well as change to current federal-provincial agreements, are necessary to implement the recommendations. The quest for a single-window approach to deal with salmon farming regulatory matters is unlikely to ever be successful, but with clear provincial policy, and documented approaches to that policy, the approval and regulatory maze can become certain.

II. Implementation Priorities

Implementation of this report is the responsibility of various government agencies, however, consideration must be given to ensuring certain matters receive priority attention. These are not discussed in any particular order, but are considered significant implementation priorities.

A. Access to Information and Structured Opportunities for Public Participation

Many interests, including a number of First Nations, local governments, local community groups, environmental organizations and recreation / tourism interests, mistrust the salmon aquaculture industry and the agencies that regulate it. Many concerns were raised about the lack of openness to information pertaining to the industry, and about inadequate opportunities for public members to influence salmon aquaculture management decisions. In addition, it is evident that a number of local groups and individuals have a wealth of local knowledge and technical information that is not being adequately integrated into decision-making.

1. Information

Several mechanisms are recommended throughout this report about how to make information about the industry generally accessible. With respect to the process for approval, it is recommended that notice of applications be enhanced, that the proponent hold open houses to explain the proposal and that the proponent meet with local advisory working committees about the proposal. These measures would enhance the opportunities for members of the public to provide comment on proposals. It is also recommended that a central listing of all pending applications for approvals be established and maintained by MAFF, and that this listing be made available electronically. The establishment of a registry of operational farms, maintained electronically for public access by MELP, is also recommended. In time, these lists could be centralized electronically at one website location.

This report recommends that MELP and MAFF develop an annual report providing information about the issues of concern to the public. At a minimum, this would include information about the five key review issues and progress being made on implementation of the recommendations of this report. Access to certain databases should be developed on a cost-recovery basis and reports of the committees and results of research initiatives should be published and made available.

2. Public Participation

Structural changes to the review processes are needed to promote meaningful public participation in decision-making and information-sharing among the many parties with an interest in salmon aquaculture activities. The re-establishment of a policy-level salmon aquaculture advisory group, is recommended (see Recommendation 47 in Chapter 13). That group will serve government by providing advice on a set of strategic policy objectives for this

sector and implementing salmon aquaculture management reforms, particularly developing the salmon aquaculture code of practice, discussed above (see Recommendation 46 in Chapter 13). Consideration could be given to building on the Fisheries Renewal Board or its committees in re-establishing a policy group. However, this board reports administratively to a single Minister (Agriculture, Fisheries and Food). The recommended policy group must advise both the Ministers of Environment, Lands and Parks and Agriculture, Fisheries and Food regularly, as well as the Minister of Health, the Minister of Small Business, Tourism and Culture, and the Minister of Aboriginal Affairs, as appropriate.

Local advisory working committees will advise on salmon farm siting and management planning decisions (see Recommendation 7 in Chapter 4). These committees should be established initially for a few key areas, particularly where: new applications will be considered, there is a need to review a number of existing farms which will be applying for renewal of tenure, or sites need to be assessed in relation to resource impacts / conflicts and First Nations interests. Their role will include receiving comment from the public. This will enhance the existing approach of public comments on future applications being made directly to the Regional Manager for Crown lands.

B. Alternative Technology Pilot Projects

It has been suggested repeatedly that the province should regulate the type of technology that is used in the B.C. salmon aquaculture industry. Closed containment and land-based salmon farming facilities using water circulation technology were proposed by a number of parties as a means of preventing conflict and impact risks, while still enabling a salmon aquaculture industry in B.C.

It is desirable to adopt a performance-based approach wherever possible, as opposed to an approach that attempts to regulate specific technologies and practices. The importance of government involvement in exploring new technologies is, however, recognized. With a degree of government support and encouragement, the rate at which the provincial salmon aquaculture industry evolves towards the best available and feasible technology for salmon farming can be expected to increase.

B.C. has a proven reputation as a leader in the development of underwater technologies. It may be possible that this niche can be developed even further through the experimentation with, and development of, salmon farming technologies that are both cost-effective in growing salmon, and also effective in preventing potential conflicts and impacts from this activity. The five key review issues will form a basis for the assessment of the pilot programs.

The leadership that organizations such as Future Sea Farms have demonstrated should be encouraged in order to make this province a source of technical expertise that can be developed in B.C. and marketed globally.

The pilot projects recommended in Chapter 11 (Recommendation 43) should be given a high priority.

C. Coastal Zone Planning

Many individual perceptions, attitudes and values respecting the importance of coastal resources and traditional ways of life were presented to the review. Salmon aquaculture is seen by many as a threat to the quality of the coastal environment. Others view salmon farming as providing new opportunities. Incorporation of these values and perspectives into decision-making is important. However, the existing approach to siting salmon farms in response to individual applications does not easily allow for this to happen.

Integrated coastal land use planning processes are an effective mechanism to integrate social values in the decision-making process. The planning process itself is designed to integrate social values, technical information, and government policy direction. Through this means, the range of interests in coastal resources (i.e., demand) can be assessed in relation to the supply of those resources, and trade-off decisions can be made where necessary. Integrated planning is a means of proactive conflict avoidance. Given the high degree of conflict that potentially surrounds salmon aquaculture, this approach to salmon farm siting should be stressed.

At present, two imminent planning processes offer an important opportunity for proactively addressing salmon aquaculture issues — the Central Coast Land and Resource Management Plan and the Queen Charlotte Land and Resource Management Plan. Integrated planning of this nature is not common. Given the expense and logistical difficulties, it is uncertain whether government resources will allow a significant program of coastal planning in the near future. The opportunity for these imminent LRMP opportunities to address salmon aquaculture issues should be promoted. The terms of reference for these two LRMP processes should include specific provisions to ensure that the processes develop planning products that provide clear and spatially- specific direction on the future of salmon aquaculture within the planning study areas.

The Broughton area, with its existing concentration of fish farms, is located within the boundary of the Central Coast LRMP. Recommendation 8 in Chapter 4 indicates that government should review existing salmon farms to determine if remediation of impacts or conflicts is needed. In some cases this might involve the relocation of farms to more suitable sites to relieve waste discharge impacts or to address conflicts with First Nations interests. The Central Coast LRMP process should anticipate that this might occur while the planning process is ongoing. The LRMP process should also anticipate and accommodate the potential for a pilot project in the planning study area to assess alternative salmon farming technology.

D. Research into Farmed—Wild Salmon Interactions and Local Effects

The economic, cultural and social value of B.C.'s wild salmon resource is incalculable. Much of the criticism heard during the SAR about salmon farming was directed at the potential threat that it may pose to the integrity of the wild resources. First Nations participants have expressed clearly that the top priority must be on restoration of native salmon stocks and habitat. Government itself has recently given a very high priority to protection of the native salmon stocks and fishery.

Although the review has concluded, on the basis of existing information, that the provincial risk of salmon aquaculture to wild fishery stocks and other resources is low overall, the review also concluded that there are a number of important information gaps. Given the priority that virtually all groups, communities and individuals place on the wild salmon resource, priority should be given to the specific research initiatives, as described in Chapter 10, that are directed at filling information gaps related to: potential interactions between farmed and wild salmon, the effects of salmon farming on the viability and quality of shellfish resources, and the effects of antibiotics used in farm salmon feed on wild fishery resources.

E. Strategy for the Issuance of New Tenures

The review heard strong support from a number of sectors that no new farm tenures should be granted until measures to improve the management system are fully in place. Industry, on the other hand, indicates that new salmon farming opportunities are badly needed to allow the industry to stay competitive, mainly for economy-of-scale reasons. The review has concluded that salmon aquaculture presents an overall low environmental risk, but that impacts and conflicts are being experienced at some locations. In fact, recent production increases at individual farms, which are potentially the result of the current moratorium on new sites, may be exacerbating location-specific impacts.

As outlined above, the new farm operational requirements should be established by legislative and regulatory change. In the short term, if licences were issued before these changes were made, these requirements could be imposed as licence terms and conditions.

The government may wish to consider the selective regional or local release of the moratorium for some coastal areas where government is confident that operational issues can be managed through comprehensive licensing. This would require the development of regional or sub-regional strategies. The site review recommended in Chapters 4, 7 and 9 would have to be completed first, to determine the need for sites to relocate existing farms for the Broughton Archipelago and the west coast of Vancouver Island. Managing agencies should be satisfied that existing farms requiring relocation due to government policy change can be accommodated. Existing farmers should have priority.

In some regions (e.g., Broughton, Clayoquot), there may be a need for government to exercise a relatively high degree of control over the specific sites that will be allocated for new salmon aquaculture tenures — rather than opening an area to applications and then having to deal reactively with the response. Once enough area for relocation has been set aside, government could, in consultation with local interests and on the basis of existing coastal inventory and mapping information, identify specific potential sites that are considered to have basic suitability for salmon aquaculture use. Those sites could be granted through some equitable means such as a competitive proposal call (see Recommendation 3 in Chapter 4).

This approach would allow for a high degree of local participation in the siting decision. Competitive allocation (e.g., proposal call) could also be used to ensure a high standard of technology and practices at the sites as well as a market-determined value for the use of the site. Also, proposals could be evaluated in light of their contribution to social or economic objectives such as local training and employment, or a bonus bid used to offset administrative costs or to capture economic rent.

The planned pre-selection and marketing of suitable sites would allow some controlled expansion of the industry while coastal planning processes and other management system reforms are being developed and implemented. In fact, this approach to salmon farm siting may prove to be efficient and effective. This would be true especially if coastal plans were in place to provide general direction on the geographic zones within which salmon aquaculture was an appropriate use.

III. APPLICATION OF THE ENVIRONMENTAL ASSESSMENT ACT FOR REVIEWING SALMON FARMS

The review terms of reference directed the Environmental Assessment Office to consider whether or not individual salmon farming proposals should be subject to the requirement to proceed through an environmental assessment, pursuant to the provincial *Environmental Assessment Act*.

The recommendations to improve existing decision-making processes indicate that the existing approval processes can address many of the issues relevant to assessment of salmon farms if amended as recommended. Strategic level issues regarding resource use can be dealt with through coastal land use planning or the development of regional or local plans.

The recommendations incorporate many aspects of the process used to conduct environmental assessment under the Act, including well-developed applications, public notice of applications and distribution of information (through open houses and the local advisory working committees), committee-based assessment of applications and concurrent consideration of approvals. With the recommended improvements to the existing management system, the approval processes will consider the range of pertinent issues and therefore the extra approval of an environmental assessment under the Act is not necessary.

This conclusion makes answering the question regarding the development of category specifications under section 41 of the Act unnecessary. It should be noted, however, that as the procedures and information requirements become documented during implementation of the recommendations of this report, category specifications for a review of salmon farms will in effect be created.

IV. Conclusion

In developing recommendations for change to the provincial management framework for salmon aquaculture, the EAO took into account the findings of the TAT. The Technical Advisory Team concluded that salmon farming in B.C., as presently practiced and at current production levels, presents a low overall risk to the environment. This general finding was tempered by certain reservations. First, continuing concern about localized impacts on benthic (seabed) organisms, shellfish populations and marine mammals suggests the need for additional measures to protect them, and second, significant gaps in the scientific knowledge. Recommendations are made in this report regarding research priorities.

Science rarely has the ability to reach definitive conclusions on the risk or potential severity of the consequences of human interactions with complex ecosystems. In the face of this uncertainty, government still needs to make land and resource management decisions. Direction is provided by the precautionary principle which advocates the consideration and anticipation of the potential negative impacts of an activity before it is approved.

Similarly, the concept of preventative management allows government to manage to prevent certain specific effects even though not all potential outcomes can be predicted. Where the risk of environmental impacts from an economically important activity is low but the consequences of damage may be significant, the public interest may best be served by dealing with risk by being precautionary and invoking a series of measures, including: preventative management, adaptive management, and performance-based standards. In the case of salmon farming, this means reducing risk by setting high standards for farm operations based on the best available knowledge, and rigorously enforcing the implementation of those standards. And it means being prepared to alter

management practices over time to take account of increased understanding of risk and different means of reducing it. The recommended management regime will enable the province to reach the objectives of prevention and adaptive management for salmon aquaculture.

LIST OF ACRONYMS

ADD	<i>acoustic deterrent device</i>
ASW	<i>Atlantic Salmon Watch</i>
BCCA	<i>British Columbia Court of Appeal</i>
BCSFA	<i>B.C. Salmon Farmers Association</i>
CASH	<i>Cooperative Assessment of Salmonid Health</i>
CBCYC	<i>Council of B.C. Yacht Clubs</i>
CEAA	<i>Canadian Environmental Assessment Act</i>
CIIS	<i>Coastal Information and Inventory System</i>
CORE	<i>Commission on Resources and Environment</i>
CRII	<i>Corporate Resource Inventory Initiative</i>
CRIS	<i>Coastal Resource Interests Studies</i>
DFO	<i>Department of Fisheries and Oceans</i>
EAA	<i>Environmental Assessment Act</i>
EAO	<i>Environmental Assessment Office</i>
FFRC	<i>Fish Farm Review Committee</i>
FHWC	<i>Fish Health Working Committee</i>
FTC	<i>Federal-Provincial Fish Transplant Committee</i>
ICES	<i>International Council for the Exploration of the Seas</i>
KTFC	<i>Kwakiutl Territorial Fisheries Commission</i>
LRMP	<i>Land and Resource Management Plan</i>
LUCO	<i>Land Use Coordination Office</i>
MAFF	<i>Ministry of Agriculture, Fisheries and Food</i>
MAIAC	<i>Minister's Aquaculture Industry Advisory Council</i>

MELP	Ministry of Environment, Lands and Parks
MOH	Ministry of Health
MOU	Memorandum of Understanding
MSBTC	Ministry of Small Business, Tourism and Culture
RC	Salmon Aquaculture Review Committee
RIC	Resource Inventory Committee
SAR	Salmon Aquaculture Review
TAT	Salmon Aquaculture Review Technical Advisory Team
TRIM	Terrain Resource Inventory Mapping

GLOSSARY

Acoustic deterrent device (ADD). An underwater sound-generating device installed at a salmon farm to deter marine mammal predators such as seals and sea lions.

Aquaculture. The cultivation of aquatic species (animals or plants), generally for commercial purposes.

Aquatic Crown land. Provincial Crown land covered by water. This includes the foreshore, being the area between the low and high water line that is exposed at low tide.

Atlantic salmon. Salmon native to waters of the north Atlantic Ocean.

Atlantic Salmon Watch. A program jointly managed by the Ministry of Agriculture, Fisheries and Food and the Department of Fisheries and Oceans to monitor commercial and sport catches and observations of Atlantic salmon in order to help determine the abundance and distribution of Atlantic salmon in the wild.

Benthos. Life on the sea-bed.

Blue-listed species. Species classified by the Ministry of Environment, Lands and Parks as sensitive or vulnerable and therefore "at risk", but not yet endangered or threatened.

British Columbia Aboriginal Fisheries Commission. A province-wide organization mandated to facilitate the interests and concerns of First Nations in fisheries.

Broodstock. Mature salmon from which milt and roe are extracted to produce the next generation of farmed fish.

Canada-British Columbia Memorandum of Understanding on Aquaculture Development. The 1988 agreement between the federal and B.C. governments that describes their respective roles and responsibilities respecting the management and administration of salmon aquaculture in B.C.

Central Region Board. A board representing all First Nations and other communities in Clayoquot Sound, created by the interim measures agreement between the province and Clayoquot Sound First Nations, with authority to review land and resource management decisions related to Clayoquot Sound.

Coastal Information and Inventory System (CIIS). An integrated information base, managed by the Land Use Coordination Office, containing computerized inventories of coastal resources and resource use in B.C.

Coastal zone management plan. A plan that integrates and addresses the needs of a broad range of interests across a region or subregion, designates zones for appropriate uses, and is prepared through a consensus-seeking process with broad public participation and coordination among government agencies.

Community resources board. A community-based organization or "round table" that represents diverse and competing interests and participates in land and resource planning and management.

Corporate Resource Inventory Initiative (CRII). A multi-agency provincial program, coordinated by the Land Use Coordination Office, to integrate and improve B.C.'s resource inventories in support of land use planning and other resource management applications.

Crown land. Publicly owned land under provincial or federal jurisdiction.

Environmental Assessment Act. Legislation that provides a consistent, systematic, comprehensive review procedure for evaluation of the potential effects of major developments.

Environmental Assessment Office. The independent agency established by the *Environmental Assessment Act* to coordinate environmental impact assessments of proposed developments and to assess the effectiveness of provincial Acts and Regulations in preventing or reducing adverse effects of activities regulated by those enactments.

Environmental Impact Assessment. A management tool that predicts the likely environmental impacts of projects, finds ways to reduce unacceptable impacts and to shape the project so that it is appropriate to the local environment, and presents predictions and options to decision-makers. In B.C., environmental impact assessments are conducted under the authority of the provincial *Environmental Assessment Act* and the federal *Canadian Environmental Assessment Act*.

Exotic species. Any species intentionally or accidentally transported and released into an environment outside its present range.

Farm Practices Board. The board established and empowered by the *Farm Practices Protection (Right to Farm) Act* to make determinations regarding complaints about farm practices and to study, report on, and make recommendations concerning, any matter related to farm practices.

Federal-Provincial Fish Transplant Committee. A joint Canada-British Columbia body authorized by a MOU to deal with concerns about disease, genetic, ecological and other factors associated with importing and transferring live fish into B.C.

Fisheries Renewal Board. The Board of Directors consisting of government and non-government representatives empowered by the Fisheries Renewal Act to carry out the mandate of Fisheries Renewal BC.

Fish Farm Review Committee. An interagency committee (e.g., Vancouver Island Fish Farm Review Committee) authorized by an MOU that reviews salmon farm tenure replacement and aquaculture licensing decisions. Current membership includes divisions of MELP, MAFF, MSBTC, DFO and Environment Canada.

Grow-out. The stage in salmon aquaculture during which fish are raised in marine waters from the smolt phase to maturity or market size.

Guidelines. Requirements that generally do not have the force of law (statute or regulation) and therefore cannot usually be enforced through legal means. Guidelines are often used in preference to regulations where it is advisable to enable decision-makers to exercise their discretion as circumstances require or can be used to provide direction on how legislation will be applied.

Inter-agency Management Committee (IAMC). An interministry committee of senior officials in land and resource ministries in each B.C. region that is responsible for integrating all resource planning and for setting regional planning priorities.

Kwakiutl Territorial Fisheries Commission. An organization mandated by the member Kwakiutl First Nations with respect to fisheries and resource issues.

Land and Resource Management Plan. A subregional process for developing management plans that consider and address all resource values through active public participation, interagency coordination, and consensus-oriented decision-making.

Land Use Coordination Office (LUCO). The provincial body that coordinates the work of government agencies in land use and resource management and planning.

Minister's Aquaculture Industry Advisory Committee (MAIAC). A group of 15 representatives of the aquaculture industry, the commercial fishery, First Nations and recreational and environmental interests, appointed by government to advise the Minister of Agriculture, Fisheries and Food on means to ensure the orderly and responsible development of aquaculture in B.C.

Monitoring. The regular collection, generally under a regulatory mandate, of biological, chemical and physical data, using predetermined procedures and sample locations, such that any ecological changes attributable to a development activity can be quantified.

Net-cage. An open mesh net suspended from an anchored metal cage-frame.

Pacific salmon. The six species of salmon native to the north Pacific Ocean: chinook, coho, sockeye, chum, pink and steelhead.

Pathogen. A disease-causing organism.

Policies. Government commitments to follow particular courses of action in pursuit of approved objectives which may or may not be codified as law or may provide further elaboration on the application of law.

Provincial Fish Health Veterinarian. A veterinarian legislatively mandated to manage livestock disease in B.C. including disease management on salmon farms.

Provincial Land Use Charter. A set of principles of economic, environmental and social sustainability, designed by the Commission on Resources and Environment and adopted by the B.C. government, to be followed in land use and resource management planning.

Red-listed species. Species classified by the Ministry of Environment, Lands and Parks as threatened or endangered.

Regulation. A rule or order having the force of law issued by the executive authority of government. Regulations are generally made by cabinet with the Lieutenant Governor's approval order under statutory authority.

Resource Inventory Committee (RIC). A multidisciplinary and interagency committee that is responsible for developing B.C.'s resource inventory standards, protocols and data models.

Review Committee (RC). A group of representatives of various interests in aquaculture, appointed by the Environmental Assessment Office to provide advice and critical comment on the information and recommendations provided by the Technical Advisory Team; to make submissions about salmon farming to the review; and to convey information about the substance and stage of the review to the individuals they represent.

Salmon Aquaculture Review (SAR). The review by the Environmental Assessment Office of the adequacy of current methods and processes used by the Ministries of Agriculture, Fisheries and Food and Environment, Lands and Parks in reviewing and adjudicating salmon aquaculture applications and regulating salmon aquaculture operations.

Statute. A written law that expresses the will of a legislature.

Sustainability. The capability of a state or process to be maintained indefinitely. In planning, the principles of sustainability are applied to the closely linked needs of the economy, the environment, and the social system.

Sustainable Environment Charter. A statement articulating the B.C. government's commitment to put into practice eight principles needed to sustain environmental values in the province: stewardship, sustainability, the precautionary principle, user pays, environmental equity, shared responsibility, and strict enforcement of regulations.

Technical Advisory Team (TAT). A group of individuals with expertise in issues addressed by the Salmon Aquaculture Review, appointed by the Environmental Assessment Office to provide the review with objective, technically based information.

Tenure. In salmon aquaculture, a lease or licence that authorizes the use of Crown land.

Terrain Resource Inventory Mapping (TRIM). The provincial program to prepare computerized base maps for B.C. at the 1:20,000, 1:250,000 and 1:2,000,000 scales.

Transgenic salmon. A salmon that has been altered by introducing new genetic material (DNA) into its genetic composition (usually through microinjection of DNA into fertilized eggs).

Appendix 1

SALMON AQUACULTURE REVIEW TERMS OF REFERENCE

Appendix 2

Technical Advisory Team Membership and
Contribution to the Salmon Aquaculture Review

Appendix 3

Salmon Aquaculture Review:
Committee Membership, Terms of Reference and
Operating Procedures, and List of Satellite Repositories

Appendix 4

List of Organizations and Individuals That Made
Written Submissions to the Salmon Aquaculture Review and
Summary of Review Committee Comments on TAT Recommendations

Appendix 5

Summary Assessment of Existing Measures
Used to Make Salmon Farm Siting Decisions

Appendix 6

Proposed Objectives for Salmon Aquaculture in British Columbia

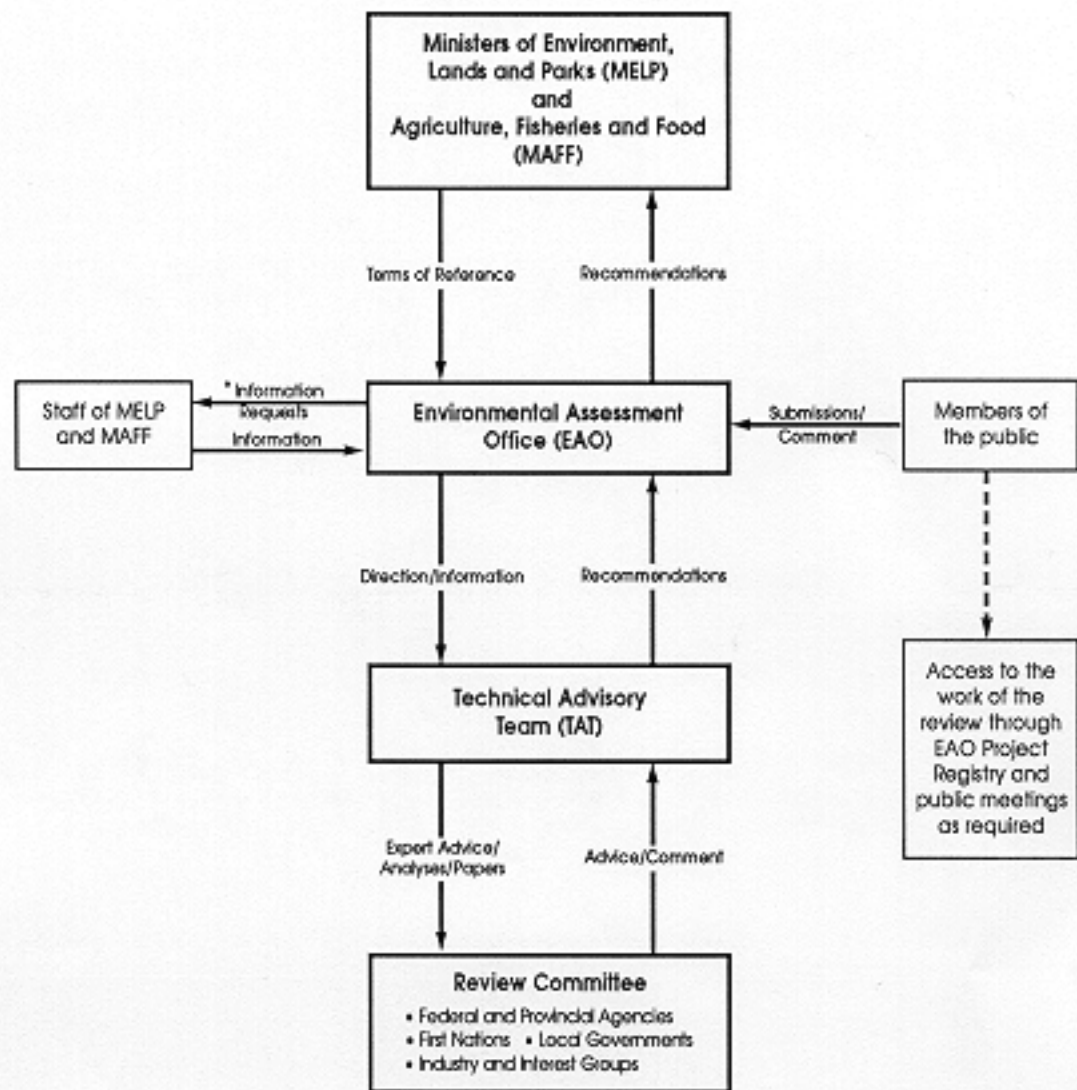
Appendix 7

Discussion of TAT Recommendations:
Summary of Industry Comments, Consequences,
Possible Responses and Cost Implications

Appendix 8

Proposed Time Frames For Implementation of
Operational/Program Aspects of Recommendations

Figure 1. Salmon Aquaculture Review Structures and Process



* Information requests arising from the review will be centrally managed by the EAO. All information prepared by the Technical Advisory Team, Review Committee and the public, and provided by MELP and MAFF will be filed on the EAO Project Registry

Salmon Aquaculture Tenures in the Broughton Archipelago

- N Study Area
- Aquaculture Sites

SCALE 1 : 40000

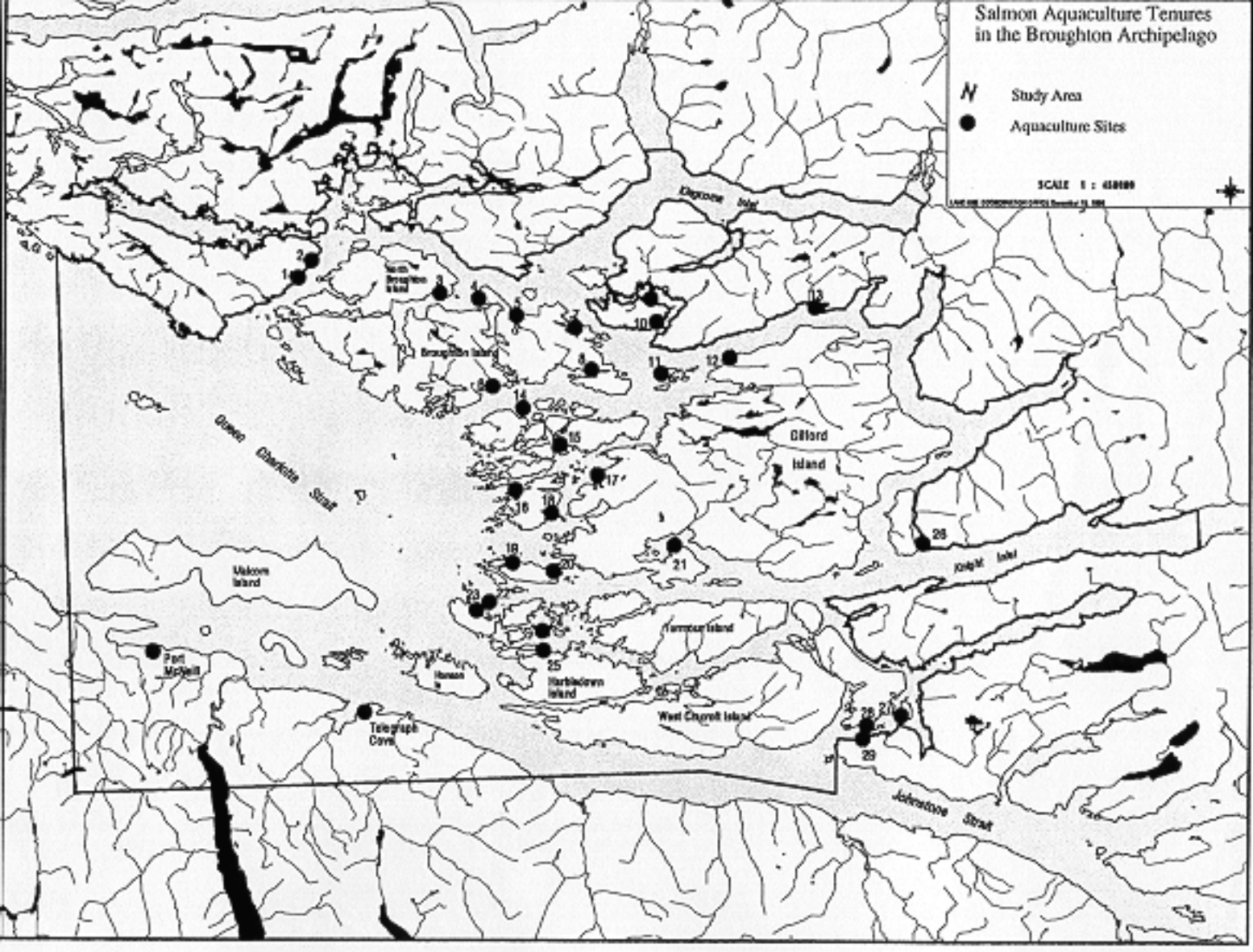


Figure 3. World Production of Wild and Farmed Salmon, 1973-1995.

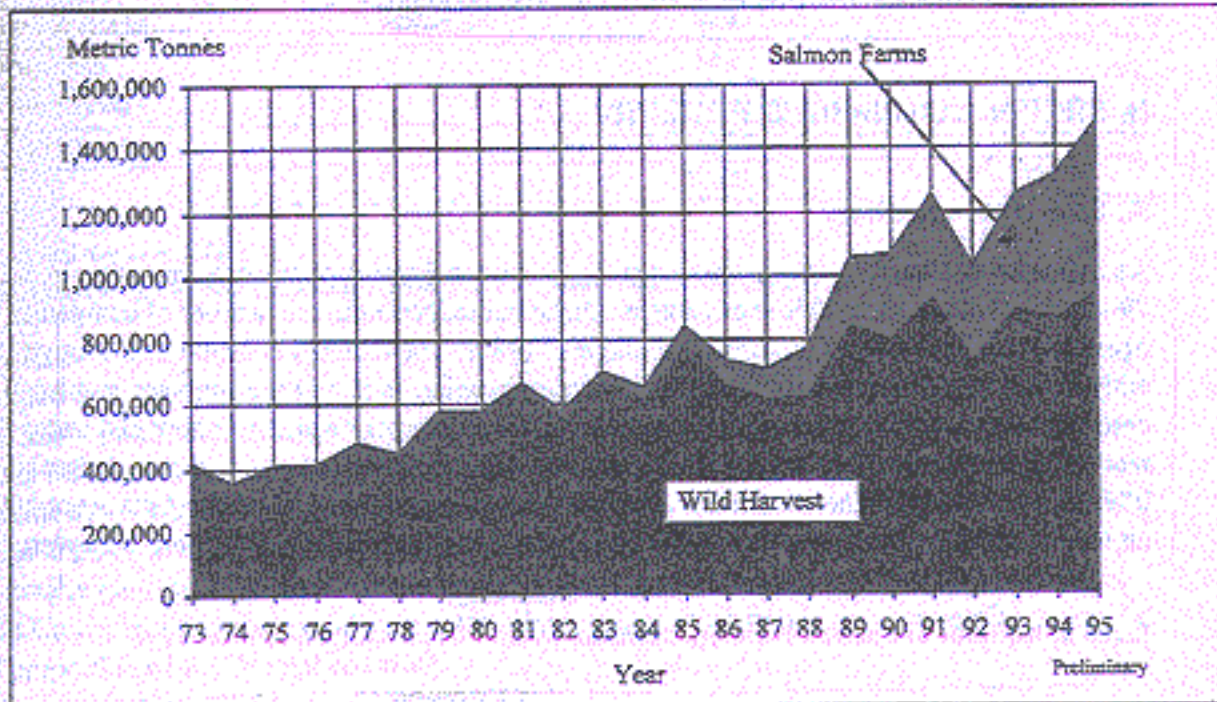


Figure 4. Location of Salmon Farm Site Tenures In British Columbia (1995).

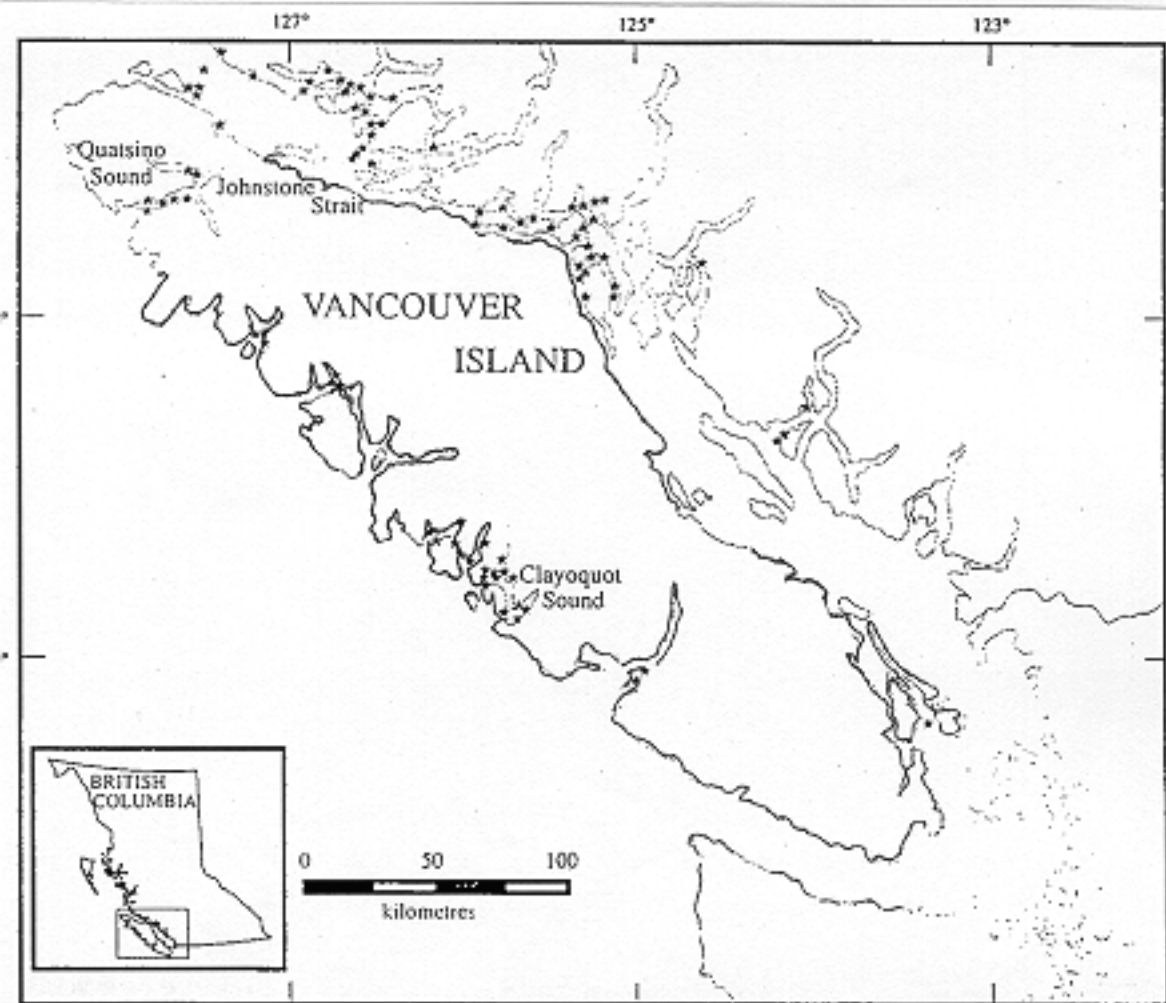


Figure 5. Stages of Aquaculture Development.

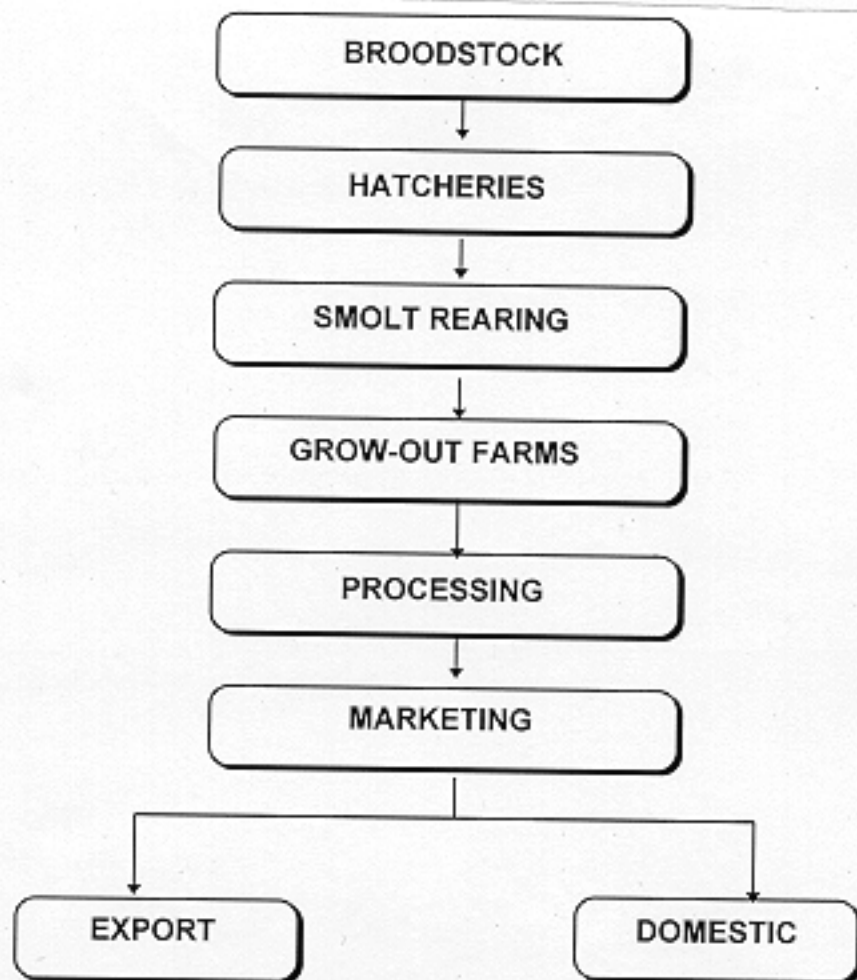


Figure 6. Typical B.C. Salmon Farm Layout

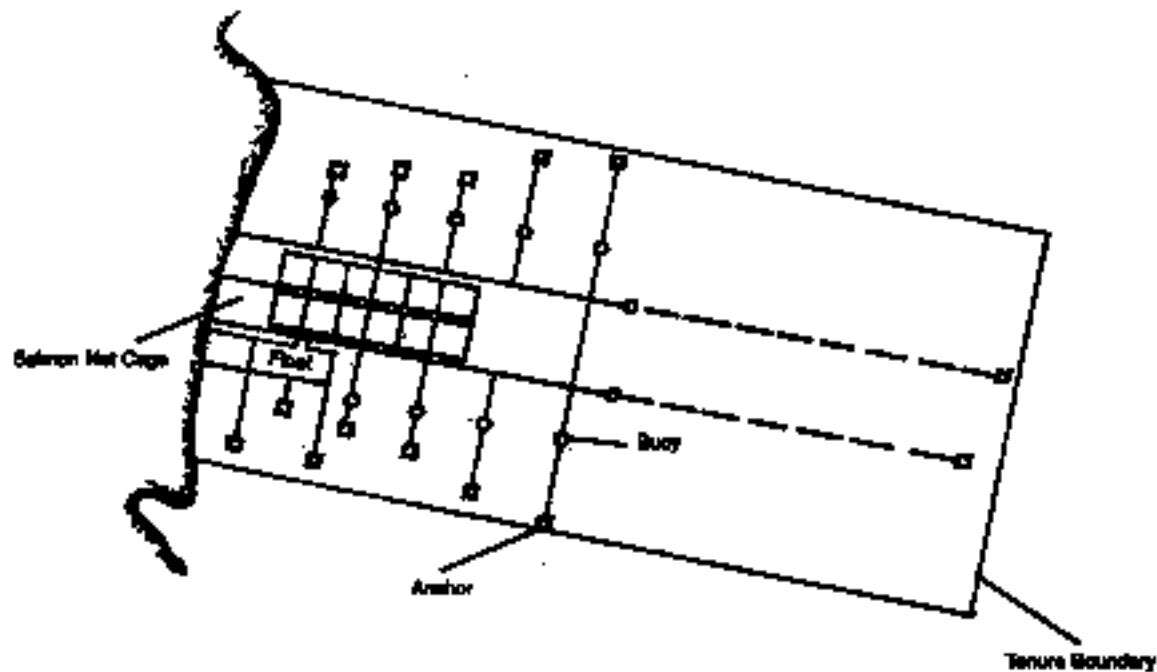


Figure 7. Salmon Net Pens and Anchor Systems.

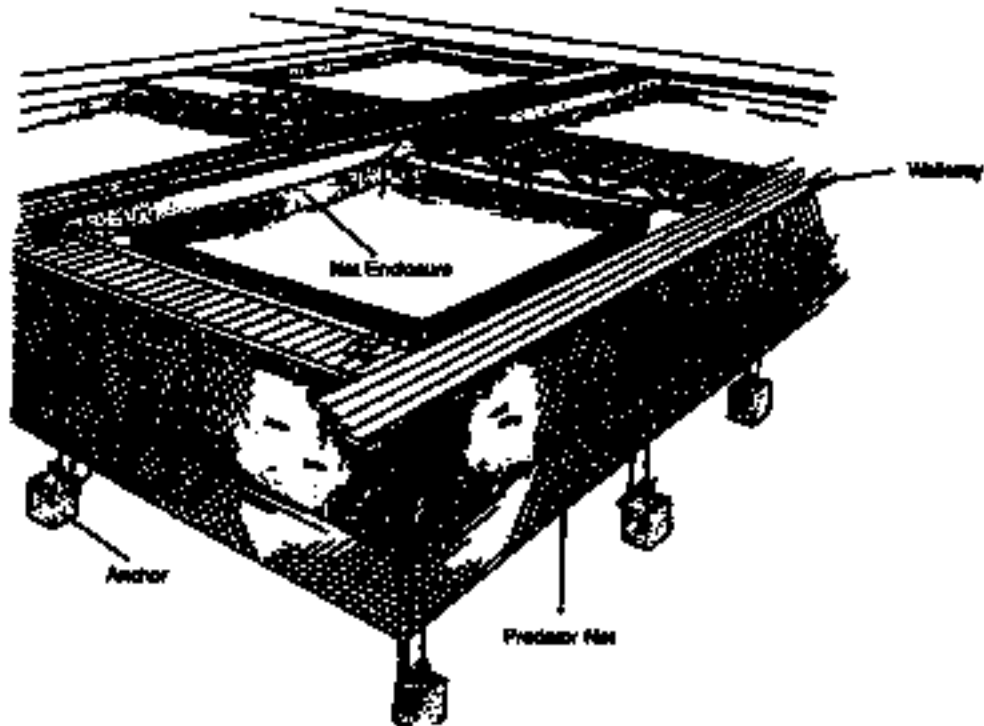
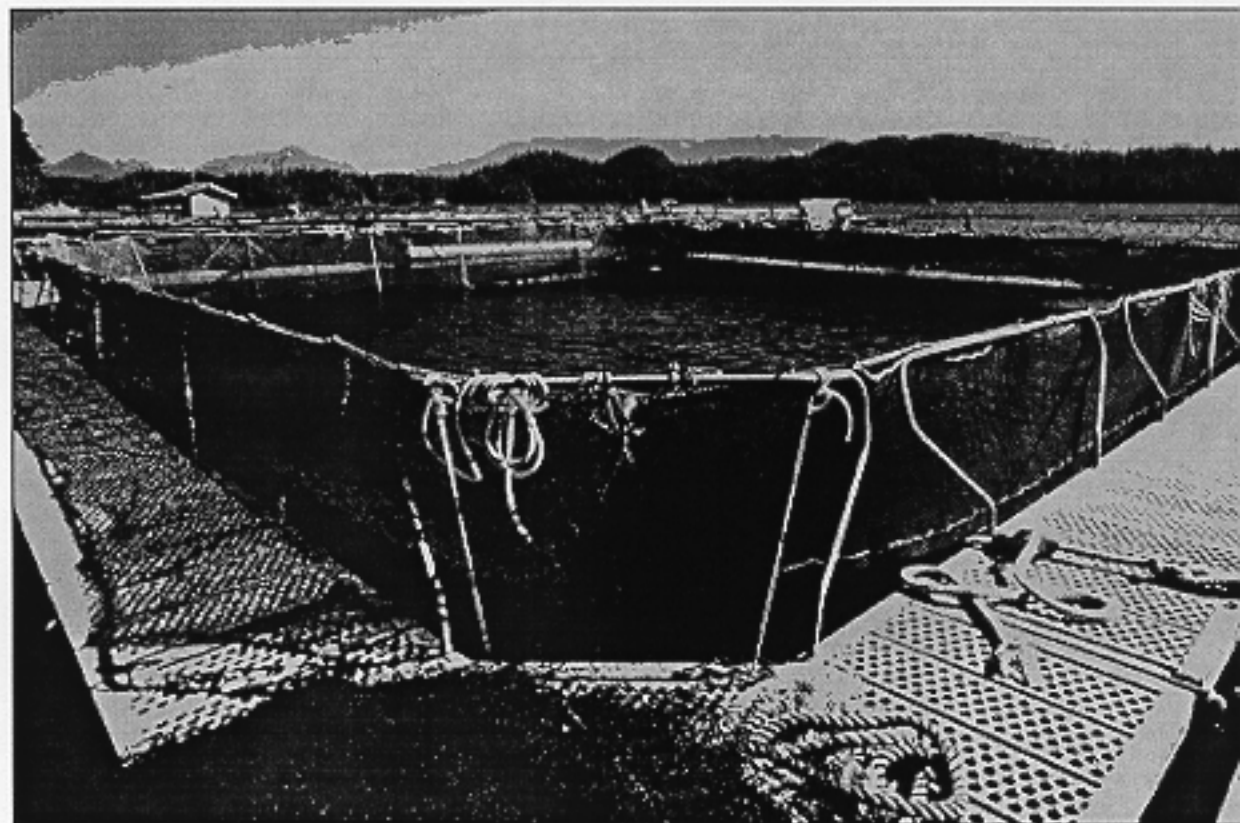


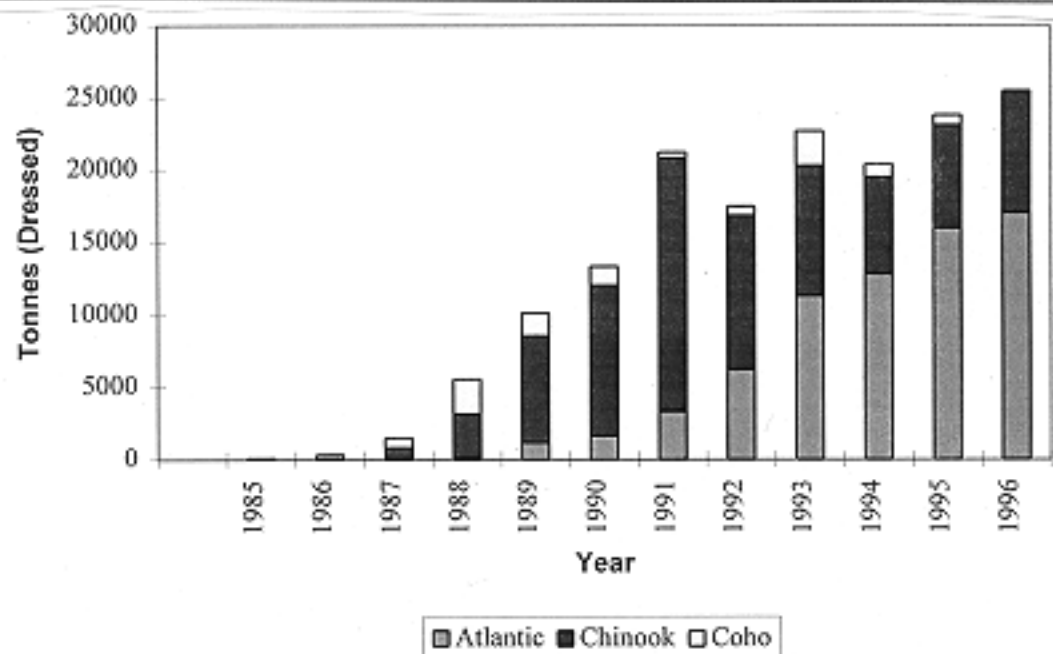
Figure 8. Salmon Farm Net-Cages in the Broughton Archipelago.



Source: BCSFA 1996.



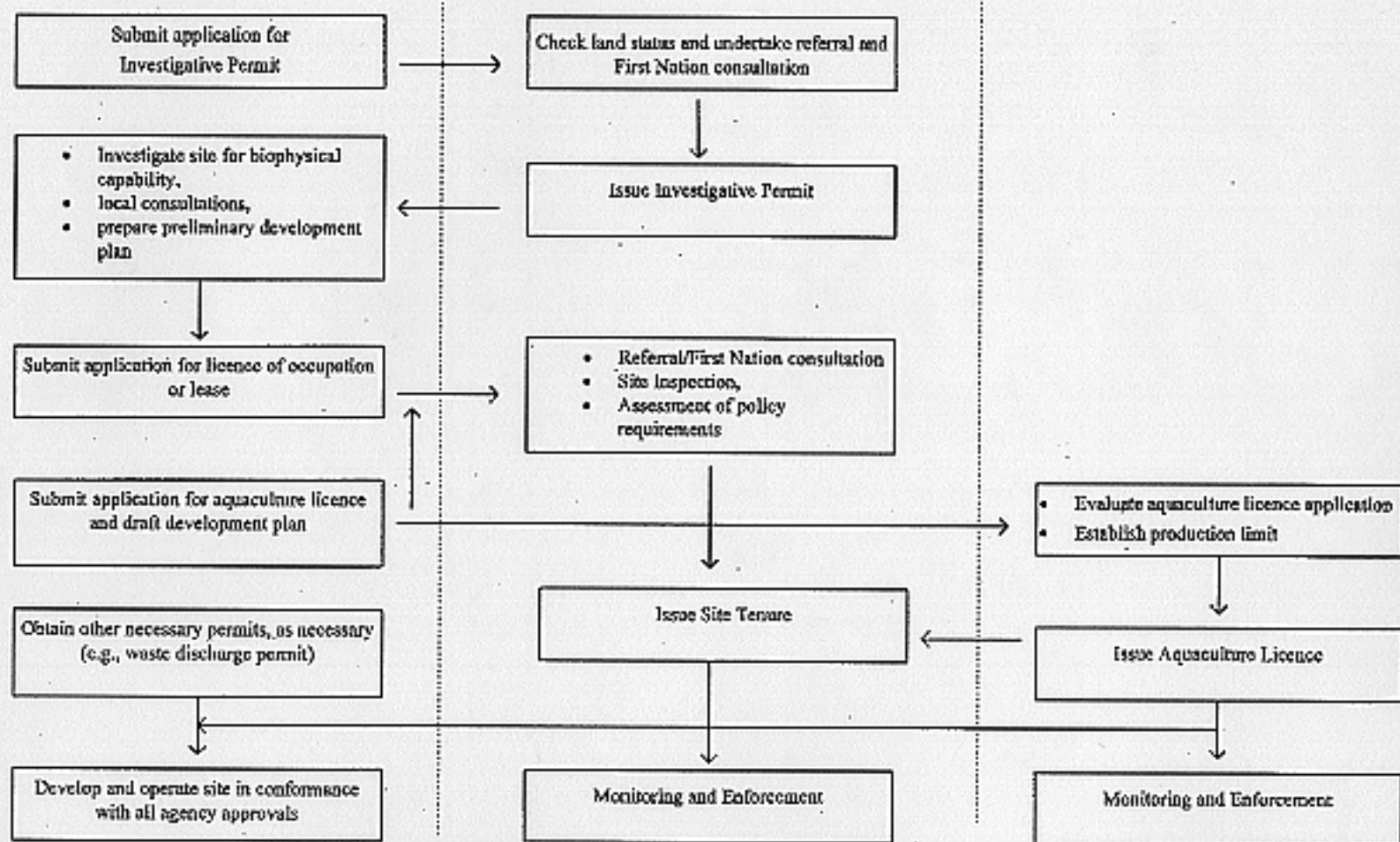
Figure 9. B.C. Farmed Salmon Production, 1985-1996



Applicant

Ministry of Environment, Lands and Parks

Ministry of Agriculture, Fisheries and Food



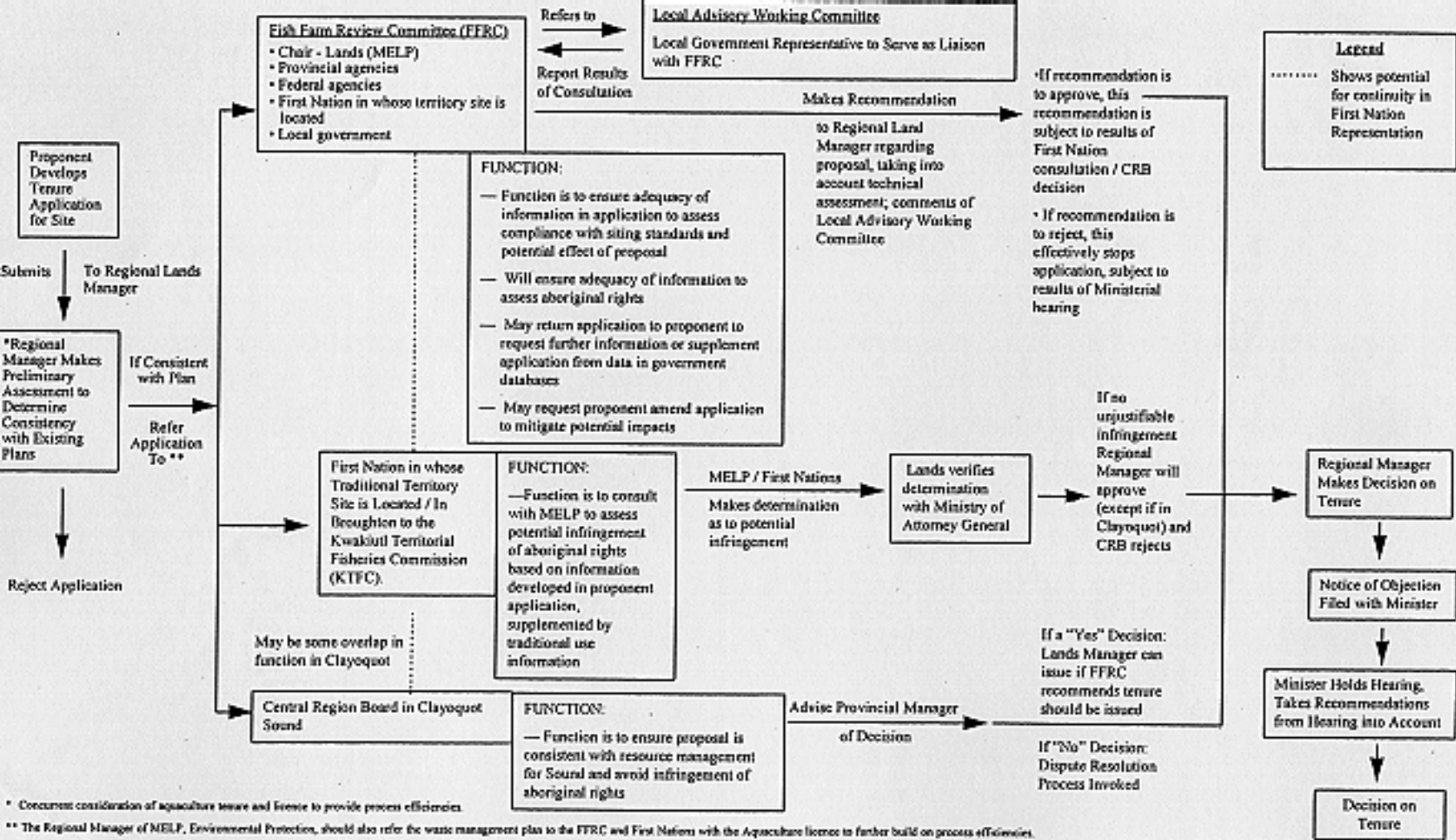


Figure 12. Application of Proposed Siting Criteria

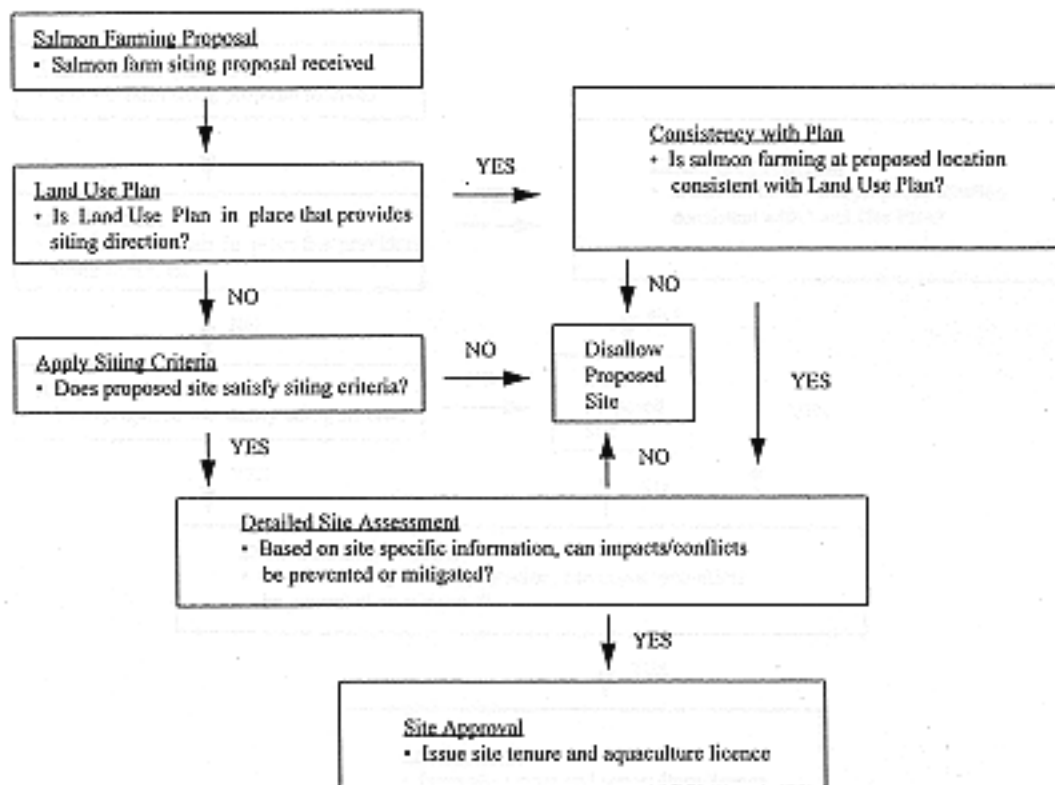


Figure 13. Potential Types of Disputes Respecting Salmon Aquaculture

1. DISPUTES OVER SITE TENURE DECISIONS

Site Licence of Occupation / Lease

Potential Disputes Between:

- * Applicant and MELP
- * First Nations and MELP
- * Third parties and MELP

Potential Disputes About:

- * Tenure allowance or disallowance decisions
- * Terms and conditions of tenures
- * Enforcement decisions / failure to enforce
- * Tenure renewal replacement decisions

2. DISPUTES OVER OPERATIONS-RELATED LICENSING / PERMITTING DECISIONS

Aquaculture Licence

Waste Discharge Permit

Fish Transfer Permit

Egg Import Permit

Licence to Kill Marine Mammals

Potential Disputes Between:

- * Applicant and licensing agency
- * First Nations and licensing agency
- * Third parties and licensing agency

Potential Disputes About:

- * Licence allowance or disallowance decisions
- * Terms and conditions of licences
- * Enforcement decisions / failure to enforce
- * Licence renewal replacement decisions

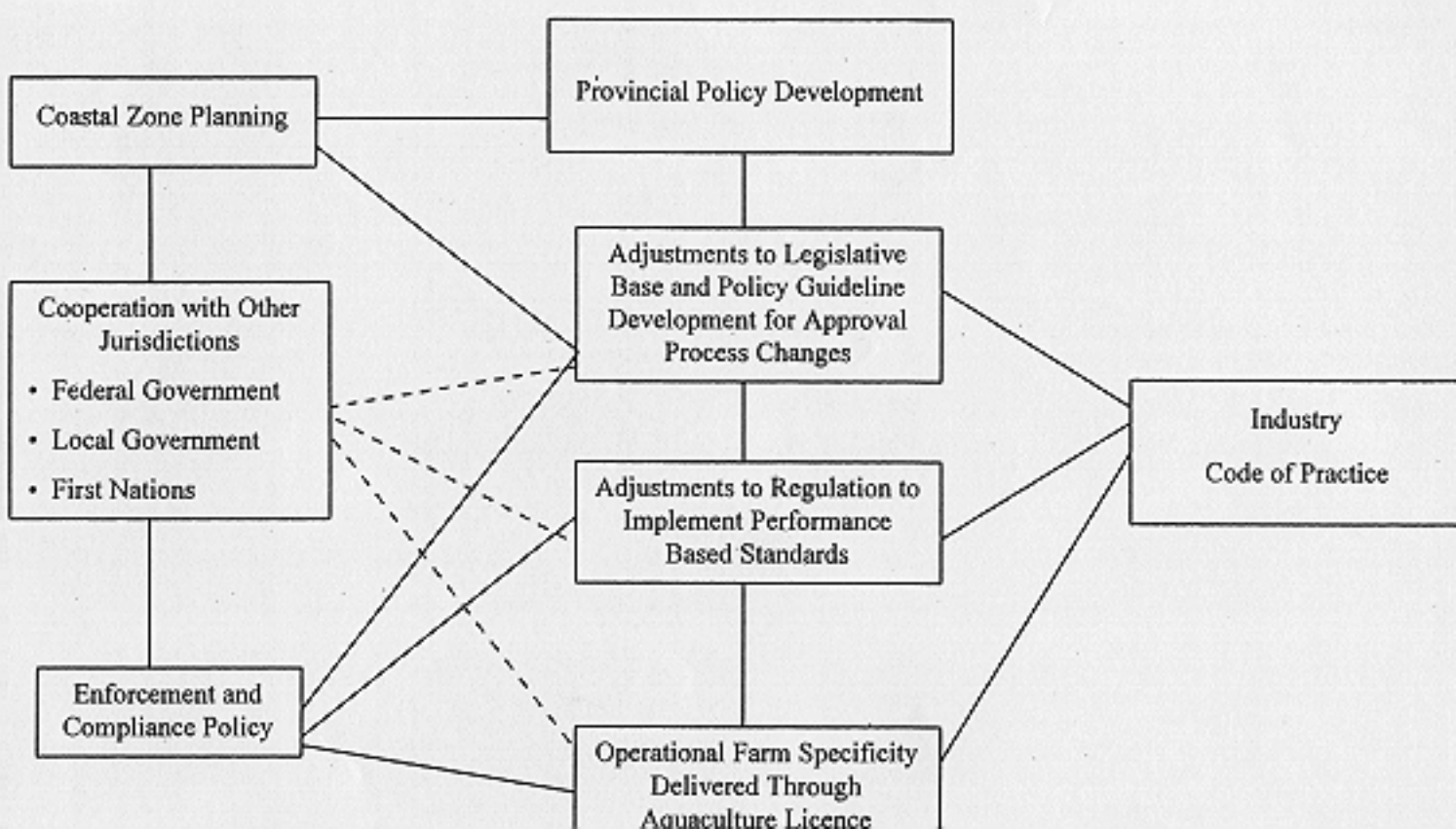
3. DISPUTES OVER OPERATIONAL PRACTICES AT INDIVIDUAL FARM SITES

Potential Complaints from:

- * Local Residents
- * First Nations
- * Recreationists
- * Tourism Operators
- * Commercial Fishers
- * Boaters
- * Others

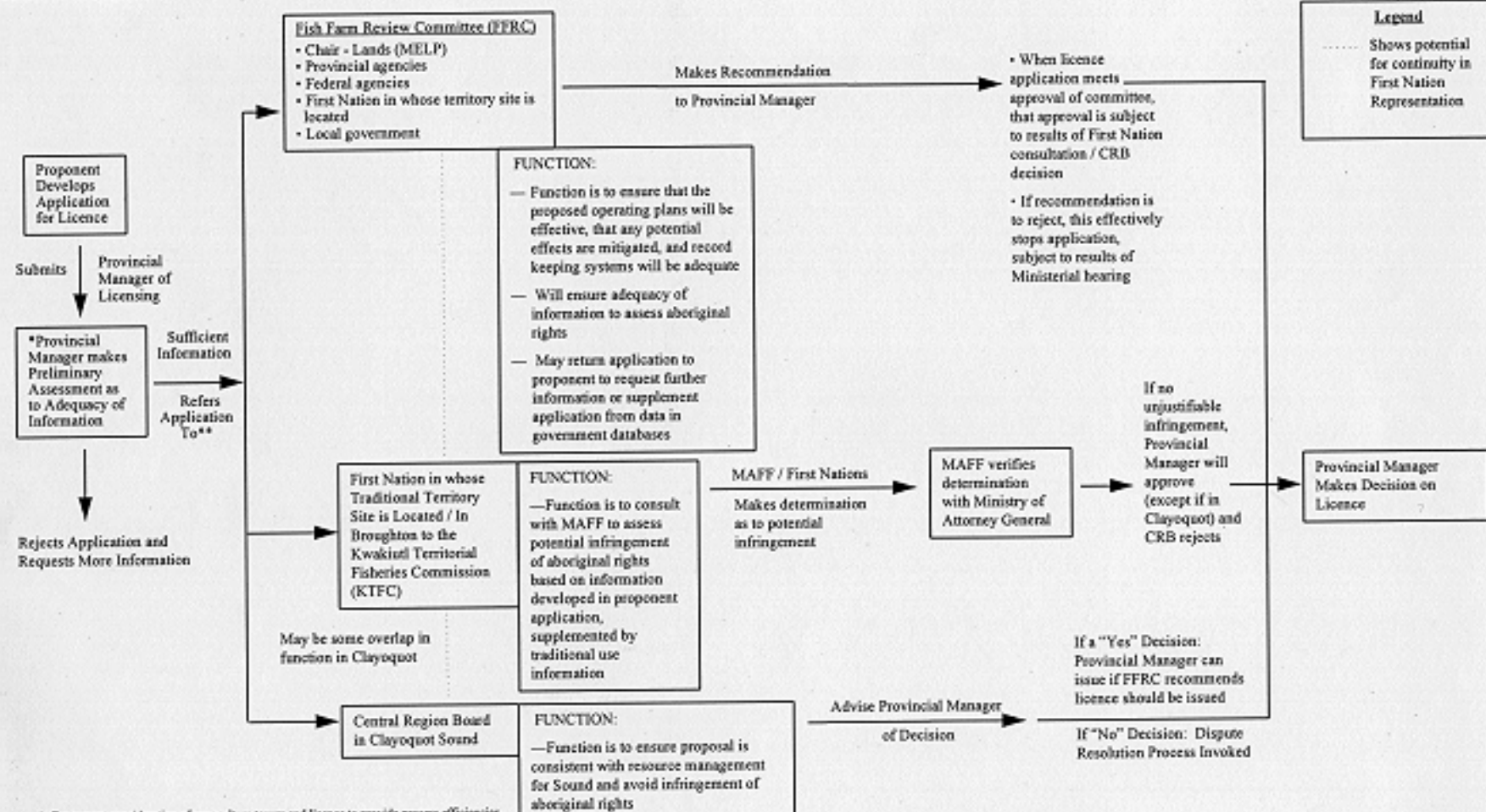
Potential Complaints About:

- * Noise, appearance, odour, etc. impacts
- * Environmental impact concerns
- * Licence / permit non-compliance



Legend

..... Shows potential for continuity in First Nation Representation



* Concurrent consideration of agriculture leases and licence to provide process efficiencies.

** The Regional Manager of MELP, Environmental Protection, should also refer the waste management plan to the FFRC and First Nations with the Aquaculture licence to further build on process efficiencies.